THE JOURNAL OF THE
BRITISH KINEMATOGRAPH SOCIETY

Vol. 10. No. 1. JANUARY and FEBRUARY, 1947

Presidential Address

FIVE-YEAR PLAN OF PROGRESS OF THE BRITISH KINEMATOGRAPH SOCIETY

At the meeting of the Society, held on 15th January, 1947, the President, Mr. I. D. Wratten, F.R.P.S. (Fellow) read the following document prepared by the Council. The paper which followed, "Fundamentals of Latent Image Formation," by Dr. W. F. Berg, will be printed in a later issue.

IN view of the new Constitution of the Society, now legalised after two years' work, the Council has decided that the present is an opportune time for the preparation of a plan for future progress extending over the next five years. With this object, it instructed the various Committees of the Society to submit detailed proposals which are here correlated for the information of interested parties.

1. Membership

The status of a Society is no higher than that of its principal membership. Under the terms of the new Constitution, the Council is required to restrict the Corporate Membership to persons of technical eminence and good standing in the industry.

Election to the Corporate Membership will, therefore, be a jealously guarded privilege. The Associateship, on the other hand, is open to any technician who has been engaged for two years in the industry.

In the field of film production it is the aim of the Membership Committee to secure as a Corporate Member every technician whose name appears on the credit titles of British films. Other sections of the industry are already well represented in the Society.

Members have henceforth the opportunity of qualifying for a still higher status, that of the Fellowship. The first fifteen Fellows were in accordance with the Constitution recently elected by the Membership of the Society. A proposal which it is felt will establish the status of the British technician and at the same time increase still further the national spirit of British production is that all technicians so qualified should be encouraged to use the initials F.B.K.S. on credit titles.

2. Lecture Programme

In none of its many fields of activity has the work of the Society shown a greater increase than in the number of meetings arranged. Including the main Society papers, Divisional meetings and those of the two provincial sections, no fewer than forty-two papers have been arranged during the 1946–47 session, in addition to six meetings arranged jointly with the Association of Cine-Technicians, which latter are to be repeated at a number of studios, making an estimated total of no fewer than sixty-six meetings during the session. This compares with eleven meetings only during the 1938–39 session. The Council submits that this forms a valuable part of the educational work of the Society.

Of the forty-two meetings above mentioned, two are to be held jointly with the Royal Photographic Society, and one with the Television Society.

It may, however, be necessary, as a temporary measure, to restrict the number of meetings in view of the work involved in increased frequency of publication of the *Journal*. Papers from students may be invited.

It may fairly be said that the status of the Society is such that any technician is honoured by an invitation to lecture to the Society. The time has arrived when the practice of other learned Societies is to be adopted, of inviting the submission of papers early in the year.

3. Technical

The work of various technical committees of the Society was of considerable importance in the years before the war. Immediately post-war conditions made it possible for members to devote their time to such work, a number of technical committees were appointed.

Two such committees have already made detailed reports, which are under consideration by the British Standards Institution, relating to length of reel, leaders and runouts for 35mm. and 16mm. films respectively.

Other technical activities concerning which committees exist, or which are under preliminary investigation, include :

(*a*) Film Mutilation.
(*b*) Technical Data Books.
(*c*) Home Office Regulations.
(*d*) Test Films.
(*e*) Studio Set Construction.
(*f*) Practical Aspects of Sound Recording.
(*g*) Camera and Sound Report Sheets.
(*h*) Distribution of 16mm. Films.
(*i*) 16mm. Projector Requirements.

Much of the work of the above committees will, of course, lead to the preparation of British standards. The Society works closely with the British Standards Institution and is strongly represented on all its committees dealing with kinematography.

4. Educational

The educational work of the Society must play a prominent part in its future development. The educational activities should cover the following fields :

(*a*) Studio.
(*b*) Laboratory.
(*c*) Theatre.
(*d*) Kinematograph Sub-Standard.
(*e*) Engineering.

The educational work may be divided into two sections : (*a*) Laboratory and generalised instruction which will be centralised in London, and (*b*) Training of projectionists which must necessarily be decentralised.

(*a*) One of the most successful activities of the Society is the two-year course in kinematography organised at the Polytechnic, Regent Street. The present course is limited to an intake of twelve students per annum. The Society would give sympathetic consideration to the views of the Industry relating to an increase of intake.

Proposals have already been discussed for the extension of this course to a third year, the additional period consisting mainly of practical work in a studio set apart for the purpose. When this can be done more practical work will be introduced into the first two years.

This, however, will involve the provision of additional plant, which in its turn will demand increased accommodation.

Another important aspect of the Society's educational work is the provision of educational courses for persons already engaged in the industry. Two courses in particular, " Sensitometry and Laboratory Practice," and " Fundamentals of Sound Recording," each of which lasts twelve weeks, have for a number of years

been well attended. There is, however, room for a very large increase in the number and scope of such courses, and it is envisaged that such courses might be organised in six or eight subjects. While it would be desirable for such courses to be centralised at the Polytechnic, Regent Street, it is appreciated that neither staff, accommodation nor equipment is adequate, and it may be necessary, therefore, either to enlist the co-operation of other Polytechnics or to organise such courses in other places, preferably studios. Manufacturers might offer co-operation.

It is proposed that syllabuses of such courses should be prepared at an early date in co-operation with the British Film Producers' Association and the Association of Cine-Technicians.

(*b*) The Society has for the past two years been studying the problem of providing technical education for projectionists, theatre engineers, etc. The recently concluded national agreement between the Cinematograph Exhibitors' Association and the National Association of Theatrical and Kine. Employees provides for training of probationers over a two-year period. The Society is anxious that its services should be used to the full in the preparation of syllabuses (a draft syllabus already exists which has been approved by interested trade organisations), and to provide graded instruction on which national certificates might be issued.

It must be emphasised that in the matter of education above all others, it is the aim of the Society to be of maximum service to the industry, and for this reason it seeks the closest association with all interested bodies, with a view to making educational courses of an essentially practical nature. To this end, the appointment of an Education Officer has been suggested.

5. Library

In the recent inauguration of a Library of technical books, the Council feels that a long outstanding want has been met, to the benefit of the membership and of the industry as a whole.

The aim of the Library Committee is to make the Society's Library a unique collection of publications pertaining to kinematography.

The Library should aim to include :

(*a*) Books under the following headings, in all cases relating to kinematography:
1. History.
2. Reference.
3. Technical.
4. Associated Sciences.
5. Cultural.

(*b*) All standards specifications relating to kinematography.
(*c*) All known periodicals, Home and Overseas, relating to kinematography.
(*d*) Patent Office abstracts.
(*e*) Publications of trade firms.
(*f*) Film scripts.

Close collaboration with the Foreign Relations Committee is desirable in order to obtain knowledge of books published abroad.

The catalogue of the Library should be published annually and all accessions should be printed regularly in the *Journal*.

6. Journal

The Society's *Journal* has previously been published quarterly, with the addition of the occasional issue of proceedings of the various Divisions. The increase above referred to in the number of papers presented to the Society, its Divisions and branches, makes it imperative that more frequent publication be effected. Furthermore it is realised that to many Members and Associates outside the region covered by the London headquarters and the two provincial sections, the *Journal* represents almost the only benefit of membership.

Monthly publication of the *Journal* has, therefore, been an important aim which is about to achieve fruition. It has been decided that the *Journal* should appear bi-monthly from January, 1947, and monthly from July, 1947.

It will be appreciated that the decision to publish monthly issues has given the Council considerable anxiety in view of the financial and organisational difficulties involved, since it is agreed that the *Journal* must at all costs be maintained at the highest possible standard in order that it may attain the status equal to that enjoyed by organs of other learned societies.

Among other objects of the Journal Committee are the publication of papers as early as possible after presentation ; publication of reports of all technical committees ; the reprinting of selected papers from overseas publications, e.g., the *Journal of the Society of Motion Picture Engineers*, *La Technique Cinématographique*, *Kinotechnik* when republished, etc., and on the circulation side, the receipt of the *Journal* by every technician employed in the industry, every kinema theatre, colleges and universities, leading technical libraries, etc.

7. Theatre Division

The Theatre Division comprises theatre engineers, projectionists, manufacturers, etc., and its work covers every aspect of the kinema. Valuable papers have recently been presented on the subject of auditorium design, while the Divisional programme for the current session comprises six lectures having as their theme the need for co-ordinated design of projection equipment.

The Division was instrumental in the formation of various committees on 35mm, Release Print Make-Up, Film Mutilation, Home Office Regulations, Test Films, etc. It has also fathered the two provincial sections and has urged the development of these into branches and the formation of other branches. In the sphere of education, it is keenly interested in the training of projectionists.

8. Sub-Standard Division

The chief field of the Sub-Standard Division is, of course, the 16mm. film and its growing ramifications. The teething troubles of this standard in its new fields of use are being studied by four technical sub-committees, while the five lectures in the Divisional programme this session relate to the same aspect.

The membership of the Division naturally includes many technicians not directly engaged in the Film Industry but making regular use of kinematography for industrial, educational, technical and scientific purposes.

9. Film Production Division

Of all branches of the industry, film production has been the least represented in the membership of the Society. The formation of the Film Production Division has done much to remedy this state of affairs. As above mentioned, the Division aims to include within its membership every technician whose name appears on the credit titles of British films, and also to secure recognition on credit titles for Fellows. The Division has also been active in pressing the need for increased educational facilities for persons already engaged in the industry.

A feature of the current session has been the co-operation of the Division with the Association of Cine-Technicians, and it is hoped in the future that co-operation in the technical sphere, both with this Union and with other studio Unions, may be furthered. The Division has recommended to the Council that a Joint Standing Committee be set up to deal with such co-operation.

The Division is also actively engaged in a number of technical matters as outlined above.

10. Branches

There exists in the provinces a very healthy demand for the establishment of localised activities of the Society. Theatre Division sections have been established in Manchester and Newcastle-on-Tyne, both of which have during the past and current sessions organised excellent lecture programmes ; these sections are not yet branches of the Society but merely sections of the Division. At the sugges-

ion of the Theatre Division the Council has in view the establishment of branches ›f the Society in the following centres :

Birmingham, Cardiff, Leeds, Manchester, Newcastle, Glasgow, and Belfast.

The Society also has growing memberships in Australia and India, and it is ıoped in the near future to establish branches in both countries and also in other ountries of the Empire, e.g., South Africa. The establishment of branches must, ıowever, await an extension of the central organisation of the Society.

I. Foreign Relations

A Committee was appointed at the beginning of 1946 to " . . . contact and xchange information with individuals, firms and societies in foreign countries," nd with power to arrange representation of the Society in such countries and to ffect the exchange of Journals. Valuable contacts have been established with the ɔllowing countries: Czechoslovakia, France, Hungary, Russia, Spain, Sweden nd Switzerland. The Committee is watching developments in other countries, nd in particular is ready to resume relations with technical bodies in ex-enemy ountries.

An important aim of the Committee is to encourage the adoption of British tandards in all foreign countries, with which object the Society strongly supports ıe British Standards Institution in its efforts towards international standardisation.

The Committee has done much to facilitate the inclusion of foreign periodicals ı the Society's Library.

2. Co-operation with Other Bodies

In addition to the bodies above-mentioned, co-operation in some form or other as during the past year taken place with the Kinematograph Renters' Society, the ncorporated Association of Kinematograph Manufacturers Ltd., the Central)ffice of Information, the Ministry of Labour, the Ministry of Education, and the oard of Trade.

THE JOURNAL

THE more frequent publication of the *Journal* has long been an aim of the Society. The increased number of papers arranged by the Papers Comıittee, the Divisions and the provincial sections, and the growing demands on ɔace of news of the Society and of other matters of technical interest, make an arly increase in space imperative.

Increased frequency of publication was until recently prohibited by the paper estrictions. These restrictions are however now eased, and the Journal Comıittee is happy to announce that during the present year the Society's *Journal* ʼill become a monthly publication.

In view of the organisational problems involved, it has been decided not to ıstitute monthly issue at the moment. As from the present issue, the *Journal* ʼill appear bi-monthly, and from July next it will be published monthly.

At the same time, the increasing circulation of the *Journal* has made it possible ɔ reduce the cost to subscribers. The price per issue is now reduced to 3s. 3s. 2d. post free). The subscription rate for the present year (nine issues) is 7s., and for a full year 36s., in both cases including postage.

Fellows, Members and Associates will continue to receive the *Journal* free of ıarge. The special rate of subscription to Students will for the moment remain : 10s., since the Council feels that the *Journal* is of especial value to Students.

It will be of interest to members to know that the *Journal* enjoys a very wide verseas circulation. Copies are sent to practically every part of the British mpire, and to the following countries : Algiers, Argentina, Austria, Batavia, elgium, Czechoslovakia, Egypt, Finland, France, Holland, Italy, Norway, alestine, Portugal, Spain, Sweden, Switzerland, the U.S.A., and the U.S.S.R.

D.C. VERSUS A.C. AS PROJECTION ILLUMINANT

Read to the B.K.S. Theatre Division on 17th March, 1946.

I. DIRECT CURRENT

R. E. Pulman (Fellow)*

ONCE upon a time, the A.C. carbon arc was used only as an emergency standb to D.C. carbon arcs. Housed in a scissors or straight burner were white flame carbons of up to 22 millimetres in diameter. Everything about their operatio was uncertain, to say the least. From this ugly chrysalis has emerged the beautifu butterfly that we know today as the modern A.C. high-intensity carbon arc Special copper-coated carbons of less than half the diameter but loaded to the sam current are now housed in modern projector arc lamps fitted with relatively fas optical systems and highly efficient automatic feeds.

The A.C. carbon arc light source in its present form is nothing new, howeve In 1935 the author had the opportunity of studying the use of this source in Franc and at that time it was widely used on the Continent. As a result of investigation a test installation at a kinema was carried out early in 1936 and has been runnin satisfactorily ever since, a matter of ten years. In this installation the arc lamp wa fed with alternating current at 150 cycles to eliminate the noticeable beat fron which most A.C. arc lamps suffered at that time and which has now been overcome This beat originated of course from the difference between the 50-cycle suppl and the 48-cycle picture frequency.

Misconception seems to exist in several directions and the main purpose of thi short paper is to present the author's conclusions regarding the merits and demerit of this A.C. source as compared with an equivalent D.C. source of the Supre type.

Screen Illumination

The only standards of screen illumination available are those suggested by th Society of Motion Picture Engineers of America, the latest revision of which state that screen brightness in the centre of the screen should be between 9 and 14 foot lamberts. The normal type of screen in use may be said to average around 70 pe cent reflectivity, which means that the light incident upon the screen must be be tween 13 and 20 foot-candles measured at the centre. Since we are more used t talking of averages, and allowing a normal 70 per cent side to centre distribution this means that an average of between 10.4 and 16.0 foot-candles is required.

Some years ago the author had reason to experiment with these suggeste standards and apart from technical and æsthetic considerations, experience and visua observation confirmed them to be of great value, although as a personal opinion th author would prefer to limit the maximum to 18 foot-candles centre or 14.4 averag

The next point to be considered is that of picture size. The three peak width of picture to be found in this country are 19 ft., 21 ft. and 24 ft. respectivel To illuminate these peak sizes so that the desired centre brightness of 9 foot-lamber is obtained demands the use of projectors capable of delivering 2,725, 3,320 an 4,350 lumens to the screen.

Light Output

Now let us consider the A.C. high-intensity carbon arc light source under th most favourable conditions. Although authorities differ slightly, as they alwa will, it is generally agreed in this country that the lumen output of this sour used in a properly designed projector arc lamp is around 2,150 lumens, allowir for the loss introduced by the rotating shutter embodied in the film-mechanisn This figure should be supported by the information that it stands for matched optic systems at $f/2.1$ and an 8mm. standard electrode at 26 arc volts and 90 ampères.

* Gaumont-British Picture Corporation, Ltd.

It will immediately be seen that this lumen output of 2,150 is quite inadequate for the three picture sizes given previously. In point of fact, the maximum picture width which can be illuminated to the required minimum is 17 ft. It would seem therefore that one has to decide to limit the use to picture widths of under 17 ft. or accept a screen illumination which is less than the suggested minimum standard. If we insist in illuminating the three sizes given previously, i.e., 19 ft., 21 ft. and 24 ft. in width, then we shall have average illumination figures of 8.2, 6.7 and 5.1 foot-candles, or 80 per cent, 65 per cent and 49 per cent of the suggested minimum standard. These figures moreover represent the most favourable conditions, whereas most kinemas have optical systems working at about $f/2.6$, and the $f/2.1$ system would transmit about 50 per cent more light.

Having disposed of the A.C. light source in terms of available illumination, let us consider a comparative D.C. source. A 7mm. high-intensity copper-coated electrode of the Suprex type loaded to 45 ampères will give the equivalent of 2,150 lumens with matched optical systems at $f/2.1$. Therefore the same conclusions regarding available screen illumination can be arrived at in regard to this source and the A.C. source. This type of D.C. source is capable of greater light output since the current rating is not at its maximum for this electrode. Its light output can be pushed up to 4,000 lumens with a $f/2.1$ system and 4,400 with a $f/1.9$ system, enabling adequate illumination to be obtained for picture widths up to 24 ft. under ideal conditions.

Electrical Efficiency

Electrical efficiency is of very great importance, for upon its degree depends the annual amount to be paid out for consumpton of electrical energy. The A.C. source is fed with electrical energy through the medium of a single-phase transformer and the secondary wattage for the source examined here will equal 26×90 or 2,340 watts. Suppose we again take the most favourable conditions and grant an efficiency of 95 per cent which gives an input wattage of 2,463 or roughly $2\frac{1}{2}$ units per hour. The author's own opinion is that an electrical efficiency of anything above 87 per cent at a power factor of 0.7 is unlikely to be realised. If an arbitrary figure of 1.1 pence per unit is taken, then the cost of electrical consumption per year will be roughly £34 for 3,000 running hours.

This figure compares very favourably with those of £71 for the D.C. equivalent run from an 80-volt motor-generator set or £59 for the same source but fed from the more efficient rectifier at the same line voltage. However, the tendency for some years past has been to eliminate the wasteful ballast resistance and improve overall efficiency from the 30 per cent and 35 per cent in the above cases to up to 70 per cent, and under these conditions the annual cost of electrical consumption drops to £31. This leads to the conclusion that the A.C. source or equivalent D.C. source will cost practically the same to run as far as electrical consumption is concerned, provided that modern conversion equipment is being considered, and a comparison is not being made between the efficient transformer and inefficient conversion equipment of high line voltage and using ballast resistances.

Electrode Consumption

Electrode or carbon consumption must also be considered, and in the case of the A.C. source under examination the burning conditions of 26 volts and 90 ampères give a burning rate of 5.4 in. per hour for each of the two electrodes. The equivalent D.C. source has positive electrode consumption of 7.7 in. per hour and a negative electrode consumption of 3.7 in. per hour. The annual cost, allowing for normal wastage in both cases, would be around £180 for the A.C. source (8mm. 26 volts, 90 ampères) and around £190 for the equivalent D.C. source (7mm. and 6mm., 34 volts, 45 ampères).

It can therefore be concluded that the A.C. source has no considerable advan-

tage over the equivalent D.C. source as far as cost of electrode consumption is concerned.

Installation Cost

If the A.C. source had any advantage over the equivalent D.C. source, that advantage lay in the initial cost of the equipment and the simplicity and low cost of installation. The A.C. source needed merely a single-phase transformer and the simple wiring associated therewith, whereas, until recently, high-efficiency rectifiers were very much more costly and their wiring more complicated and therefore more expensive.

We are now able to obtain single-phase rectifiers, still admittedly more costly than transformers, but capable of being located in the projection-room and with similarly simplified wiring. So vanishes the only advantage of the A.C. arc lamp.

Summary

The author submits as his case the conclusion that the A.C. source has no advantage over the equivalent D.C. source as far as electrical and electrode consumption are concerned, its use is limited to the smaller kinema if adequate screen illumination is to be obtained, it lacks the flexibility of the D.C. source, has operational difficulties that are not encountered with D.C. Its only advantage is that of initial cost and this, in the author's opinion, is outweighed by the advantages to be gained by the use of D.C. carbon arcs as projection illuminants.

II. ALTERNATING CURRENT

W. Stanley-Aldrich (Member)*

WHILE I agree in principle with what Mr. Pulman has had to say on the matter of screen lighting generally, nevertheless I have to contest a point: the relegation of the A.C. equipment to the smaller type of kinema. I agree that certain limitations tie the A.C. arc to a restricted screen area, though the limitations are imposed only by virtue of the fact that the larger kinema has not yet been catered for by the provision of larger scale equipment.

Screen Brightness

At the present time a really efficiently designed A.C. arc lamp can produce 8,000 lumens of light. This figure is immediately reduced to 4,000 lumens through the interposing of the projector mechanism shutter blades. If we make a further reduction to allow for the beat factor and general losses through the projector mechanism we get a total output of approximately 3,000 lumens. We must assume a lens aperture of the order of f 2.1, to give a fair comparison between A.C. and D.C.

In this respect I would quote an authentic test under conditions of a pre-war installation of A.C. equipment. The results of the this test were:

Picture width—22 ft.
Current—85 amps.
Pressure at arc—26 volts.
Average screen illumination with shutter running—8.5 foot-candles.

As I remember this was assessed from seven readings taken across the screen. The running cost in current was 2.4 units. or an overall electrical efficiency of about 90 per cent.

Now, 8.5 foot-candles on that 22-ft. screen was a very satisfying illumination and was ample for that kinema at that time (and as far as I know is still sufficient) for in

* Strong Electric Corporation (Great Britain) Ltd.

those days one of our very large kinema circuits was quite content to reach an average of 6 foot-candles screen illumination. The present-day trend towards higher screen illumination is no doubt prompted by the density of colour prints and also in no small measure through the inability of the exhibitor to get a more efficient screen or screen dressing.

Running Costs

As regards the comparison of running costs of D.C. against A.C., it must be admitted that today, with the introduction of the later types of rectifier of high efficiency, there is not so great a margin of saving to be claimed for the A.C. equipment as was the case before the war, when so much more or less obsolescent equipment was in use. Nevertheless there is still a good margin of difference and a considerable amount of this type of obsolescent equipment is unfortunately still in use.

It therefore rests with the particular exhibitor to decide whether he will instal the cheaper A.C. supply gear as against the rather more expensive D.C. supply gear. If the exhibitor decides that A.C. shall be his selection, then it is for him wisely to consider the type of A.C. equipment he is going to use.

Precision of Equipment

This brings me to the most vital aspect of A.C. arc lamps, an aspect which applies regardless of the make of the equipment, or the design of the gear. It is essential that the A.C. equipment be built to a closer precision than is actually necessary with the D.C. equipment. The crater formed on the front carbon of an A.C. arc lamp is smaller in area than that formed on the positive carbon of a D.C. lamp (all other conditions being equal or proportionate for our purpose). It will be seen therefore that constancy of centre is more important in the A.C. lamp than it would be in D.C. practice, as the variations of carbon centre will have a greater effect on the smaller A.C. crater area.

This means that all driving parts of the burner mechanism—all support rods, lead screws and guide rods, etc., must be turned and gauged to the very closest tolerance, as any fault in this machining will result in very greatly magnified variations when the mechanical movement is transmitted to the arc centre. Another important factor to be considered is the constancy of feed. It is absolutely essential that the motor control of an A.C. arc be designed specifically for the operation of an A.C. kinema projection arc lamp, the circuit an actual integral part of the arc circuit, each so closely related that the slightest change in the character of either will have an immediate effect on the other. By this means the feeding of the arc lamp can be almost perfect, the motor circuit acting as the nerve centre and maintaining the precise arc gap required for good operation and taking care of varying characteristics of current supply and carbon trim.

War-time Installations

Before the war it was a rule not to install an A.C. equipment unless it comprised a total equipment, that is A.C. arc lamps together with their attendant and matched inductors or transformers. When war came and exhibitors found themselves unable to replace vital parts of their supply equipment, it was felt that a temporary relief would be found in allowing the operation of any type of arc lamp on A.C. rather than close down a centre of public entertainment. This resulted in the wholesale application of A.C., in many cases to the most unsuitable situations.

In a great many instances the arcs in question were manually controlled, due to the inability of the users to get A.C. motor drives of any sort. These latter cases were of course the worst, as A.C. *cannot* be controlled by hand feed operation. Imagine the arc gap closed to its limit and then let it burn away to its maximum gap. On the screen results under such conditions I will not dwell, but on the effects on the inductor, from my personal experience and to my not inconsiderable cost, I can. An inductor rated to operate at 80 ampères 25 volts, characteristics which

are perfectly normal under average conditions, found itself loaded to 120 ampères when the gap was closed, yet would naturally receive no benefit from the fact that only 60 ampères were being drawn from it when the arc had burned to its maximum gap.

Stroboscopic Beat

Screen " beat " is a condition which is peculiar to A.C. screen illumination and is set up through the phasing of the cycles of the current supply with the shutter blades of the projector mechanism ; its results vary with different types of shutter blades and with varying projector speeds. The effects, whilst they are discernible to the expert, are not discernible to the public eye. The almost total elimination of these effects is attained where a correctly designed and consistently fed lamp enables the arc to maintain a constantly incandescent state of crater.

This beat has no eyestrain effect on the audience. I make this statement with the authority of ten years' close experience. The public is still unaware what puts the light on the screen and much less aware of the electrical composition of the light.

In summing up, I believe that today there are some seven hundred kinemas in Great Britain using the A.C. system. Of this number I have personal knowledge of the full satisfaction of some three hundred kinema exhibitors and I am sure that their satisfaction is not born entirely of ignorance of modern equipment trends or their responsibility towards their patrons.

DISCUSSION

Mr. C. G. Heys Hallett : Mr. Pulman took 90 amps. A.C. as giving the same light as 45 amps. D.C., giving a ratio of 2:1 ; actually it is more accurate to take the ratio of 2:15. Under those conditions we made the carbon costs of A.C. about 66 per cent higher, whereas Mr. Pulman gave them almost equal.

Mr. Stanley-Aldrich referred to the screen beat, and I think dismissed it rather lightly. The beat varies considerably, and the reason is that it is extremely sensitive to focus.

Dr. F. S. Hawkins : I believe it is necessary for stable running of an A.C. arc that the power factor should be from .2 to .4—a very low figure. Are any steps being taken to correct this low power factor ?

Secondly, is the actual light source that you use under optimum conditions the crater or the luminous gas in between ? We have in our laboratories taken slow-motion films of the ordinary A.C. arc run from a 50-cycle inductor, taken at 3,000 frames per second. That does show quite clearly that the luminous gas in between is of a great brightness, as compared with the other parts of the arc. We have also observed that the beat is bad when you are only picking up the light effectively during half a cycle. You can observe in the film that the two craters are only bright in alternate half-cycles, whereas the luminous source comes up to full brightness each half-cycle.

Mr. Stanley-Aldrich : I have knowledge of only one type of equipment and no steps are taken outside the transformer to provide power factor correction. Our works readings show a very low power factor, of the order of .1, on no load, but about .75 or .76 on load.

Mr. S. A. Stevens : If you take a D.C. arc and gradually increase the percentage ripple the flame gradually gives more light as the ripple increases.

Mr. C. G. Heys Hallett : The fact that the light comes from a gas and not from a solid is easily calculated, because as the size of a sphere is reduced the ratio of volume to surface area increases enormously, and the rate of cooling of a large object like the end of a carbon is so slow that it would not possibly vary at the rate of 50 cycles.

Mr. C. H. Champion : In a demonstration we made by colour film it was quite easy to see the tail flames disappear, and then the gaseous ball, finally leaving the active surface as giving the most light

THE DESIGN OF STUDIO LIGHTING FITTINGS*

. S. Hawkins, Ph.D., A.R.I.C. (Member) and W. R. Stevens, B.Sc., A.M.I.E.E., F.I.E.S.

Read to the B.K.S. Film Production Division on 1st May, 1946.

THIS paper deals with the principles of design of kinema studio lighting fittings, rather than a detailed description of particular units. It has been found con-enient to divide the subject matter into three main parts, namely, light, heat and ›und.

. LIGHT. 1.1 Light Sources

The light sources most widely used in kinema studios at present are tungsten lament (incandescent) lamps for black-and-white film, and high intensity arcs ›r colour film. Some colour film, particularly 16mm. stock, is designed to be xposed to incandescent lamp light, but generally the high illumination required an only conveniently be obtained with high-powered arcs. Fortunately the I.I. arc gives light of a colour resembling daylight† and is therefore, a convenient ›urce for colour film which may be exposed outdoors or in the studio.

The H.I. arc is also used occasionally for black-and-white film work where a articular high-light effect is required, such as sun streaming through windows, ut the high sensitivity of modern panchromatic stock makes the incandescent ımp sufficiently powerful and more convenient than the arc.

This paper will not deal with the use of high pressure electric discharge lamps, ince although they may eventually have a profound effect on studio lighting, they are ot in general use at present.[1]

We are concerned with the size, shape and brightness of the light sources avail-ble: these details are summarised in Table I for the sources in most general use ı studios. It will be seen that H.I. arcs are considerably more bright than ıcandescent lamps.

The light distribution of these sources is also a matter of importance. Figs. 1 and show light distributions for an incandescent and a H.I. arc respectively, and it is vident that while the incandescent lamp gives half its light output forward of the lament and half backward, the H.I. arc gives practically all its light forward of the rater. Analysing the arc lamp distribution in more detail we find that of the total ght output 70 per cent is given in the region $\pm$ 60 degrees from the axis of symmetry normal to the plane of the crater). Any light collecting system tends to grow apidly in size in order to pick up flux beyond these angles. Fig. 3 illustrates this oint: the lens *AB* picks up 68 per cent of the total light emitted by the crater, nd the lens *CD*, rather more than 3 times the diameter of *AB*, picks up 94 per cent. 'hus for an increase in lens diameter to 3 times (involving an area increased 9 mes) the gain in light collected is only 26 per cent. This does not mean that a esigner is unwise to attempt to use the light emitted at large angles to the optical xis, but that he will have difficulty in doing so without producing a rather cumber-›me and expensive fitting.

A similar argument can be applied to the design of fittings for the incandescent ımp: the effort to pick up more and more flux becomes more and more expensive, ith the added complication that we must attempt to use both forward and back-ard light to get a highly efficient fitting. This is generally achieved in one of two ays:

(*a*) If a lens is the main optical component, a backing mirror is used to collect the backward light.

* Communication from the staff of the Research Laboratories of the General Electric ompany, Ltd., Wembley, England.

† "Daylight" is very variable in colour—more so than most people realise—but a 150 mp H.I. arc gives a colour resembling that of a sunny day at noon.

(*b*) If a mirror behind the lamp is the main component the forward light is allowed to contribute directly to the light distributed by the fitting.

1.2 Light Distribution

We shall not discuss here special effects devices* but the "Illuminator" which is the basis of all studio lighting, and the broadside, scoop, and similar diffusing units. The optical design of the broadside unit is simple. It consists of a vitreous enamel or other durable white surface which diffuses the light falling on it, and this diffused light plus the direct lamp light is available for the general lighting of large areas. The shape of the reflecting surface is not critical; the light distribution of the fitting is determined almost entirely by the shape of the front opening of the reflector and the position of the light source relative to that opening. Thus in Fig. 4 the reflector surfaces *A* and *B* will give substantially the same result with the filament at *F* and the front aperture remaining unchanged. Polar curves of these two are shown in Fig. 5.

TABLE I

TYPICAL LIGHT SOURCES

Type of Source	Size, mm.		Effective Brightness, Candles per sq. cm.	Fil. Type
Incandescent	Height	Width	1,000 to 2,000	
5 KW	32	40		6 Bar Flat grid
2 KW	23	24		8 Bar Flat grid
500 W	15	14		6 Bar Flat grid
H.I. Arc	Effective Diam.		50,000 to 70,000	Carbon Size
150 Amp.	12.5mm.			Positive 16mm. Negative 11mm. diameter
120 Amp.	11mm.			Positive 13.6mm. diameter Negative 10.0mm diameter
65 Amp.	6.5mm.			Positive 9mm. diameter Negative 7mm. diameter

If specular reflectors, such as silvered glass or polished metal, are used the reflector shape controls the light distributions, and this is also true with semi-diffusing surfaces such as matted aluminium; but broadsides are generally made in vitreous enamel or similar material.

The optical problems associated with the "Illuminator" are more interesting and it will be well to discuss the subject in some detail, particularly as an air of mystery seems to have grown round the design of prismatic glassware most generally used.

* For example, those with a "Magic Lantern" optical system which are able to produce light patches of well defined and controllable shape.

The first thing which the designer must know is the light distribution required from his fitting. It is difficult to get, from British studios at least, a clear statement of requirements. Fortunately for the last few years good quality lenses have been available and the instruction to the designer has usually been to " get a distribution like that "—" that " being identical with the existing lens. Up to a point this is

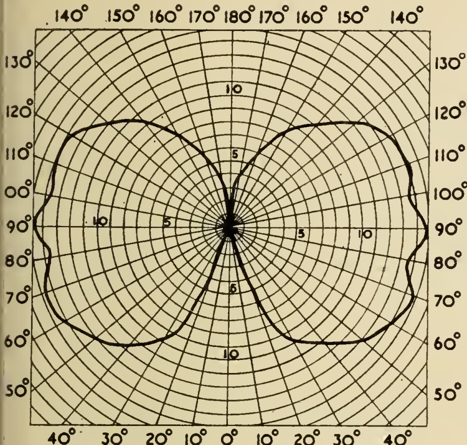


Fig. 1. Light distribution in vertical plane from a 5 KW bi-post incandescent projector lamp. (Arbitrary units of intensity.)

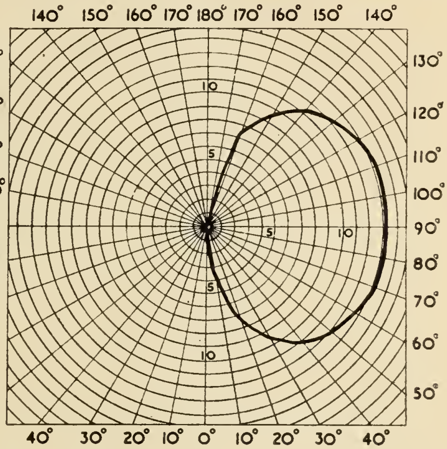


Fig. 2. Light distribution in vertical plane from a 150 amp. high intensity arc lamp. (Arbitrary units of intensity.)

satisfactory. But on questioning studio technicians one finds a wide diversity of opinion : some think the existing units will not spread the light sufficiently, others think the " spotted down " condition not sufficiently concentrated. Some think the light patch produced has too hard an edge ; some regard it as too soft. Some engineers quibble at the slightest variation in illumination in the light patch, forgetting that in the studio they cover the lens with diffusers so dense as to obliterate almost every trace of the original distribution. It may be that the existing light distribution is all that is required, and evidently it must be fairly good or films would not be made with the facility which is now common. The important thing is, however, that cameramen and other studio technicians should make, from time to time, a critical survey of their requirements and then discuss with designers any modification to light distribution which they think desirable.

If we can dispose of the idea that there is nothing better than what exists already, and if we can achieve active co-operation between users and designers in this country we may well make valuable progress.

The design at present taken as standard gives a patch of light on a surface 10 ft. from the fitting which can be varied broadly speaking from about 8 ft. diameter to 2 ft. diameter. The lens diameter has been standardised by the British Film Producers' Association as shown in Table II. Focusing is obtained by changing lamp position relative to the lens.

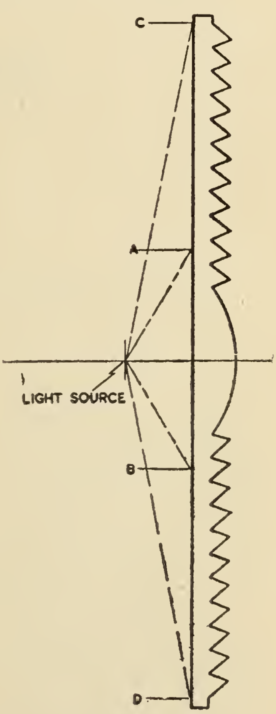


Fig. 3. Effect of lens size on pick-up of light

TABLE II

LENS DIAMETERS FOR KINEMA STUDIO ILLUMINATORS

Lamp	Rating	Lens Diameter
Incandescent	500 watts	6 in.
Incandescent	2 KW	10 in.
*Incandescent	5 KW	14 in.
H.I. Arc	65 amps	8 in.
*H.I. Arc	120 amps	14 in.
H.I. Arc	150 amps	20 in.

* These lenses are of the same diameter but different prism formations.

1.3 Optical System for Illuminator Lens

It is not necessary in this paper to discuss detailed points in design of a prismatic plate lens. There are two main problems :

(*a*) Design of prisms.
(*b*) Diffusion on back of lens.

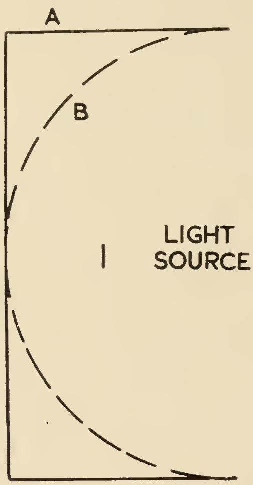


Fig. 4. Optically equivalent diffusing fittings

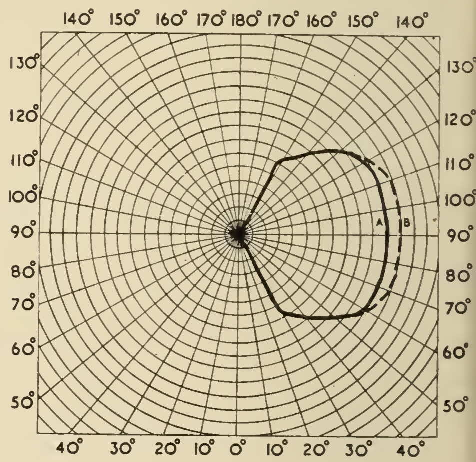


Fig. 5. Polar curves of diffusing fittings

Fig. 6 shows the main task which the lens must perform. If P is a section of a correctly designed plate and A and B the extreme positions of the source then rays Aa must spread to the required amount whilst rays Bb must have only a small divergence. Each of these rays is, of course, associated with a small cone of light depending on the source size and its distance from the lens as shown in the lower half of the diagram. If the lens is designed to have its best performance with the source at A—that is to have a perfectly uniform distribution—then it is found that with the source at B the light is not sufficiently concentrated. If the lens is designed to give maximum concentration with the source at B, the spread position will be found to show a dark centre. The art of the designer is to get a satisfactory compromise between the performances at these extreme positions.

Let us suppose that we have a lens designed correctly for source position A, that is to give a uniform wide-spread beam. This can be done by obeying a simple mathematical formula.*

* British Patent No. 470,432.

From such a lens we shall get light rays such as Aa, Aa_2 and Ax (the straight through position) in Fig. 7. If now we move the source towards B, the rays shown will gradually contract, and it will be found that at a source position between A and B, such as C, the ray Cc_1 will cross over the axis while ray Cc_2 is still divergent. By the time the source reaches B giving a ray Bb_1 which is parallel to the axis, the ray Bb_2 will diverge. The straight through rays from A, C, and B at all times fall in the centre of the beam produced by the lens. The best concentrating position for the source will be where rays such as Cc_1 diverge as much on one side of the axis as do rays Cc_2 on the other side. This process of crossing over produces an effect which is apparent to some extent in all lenses of this type, that in some positions intermediate between spot and full spread, the light distribution is not uniform. As the beam is spotted down rays such as Cc_1 reach the centre of the beam and give a bright core rather before the rays from the edge prisms (such as Cc_2) reach the centre. While these " edge " rays are closing in the others are crossing over the centre and making it bright. The result is a bright beam core with a lower level of brightness surrounding it.

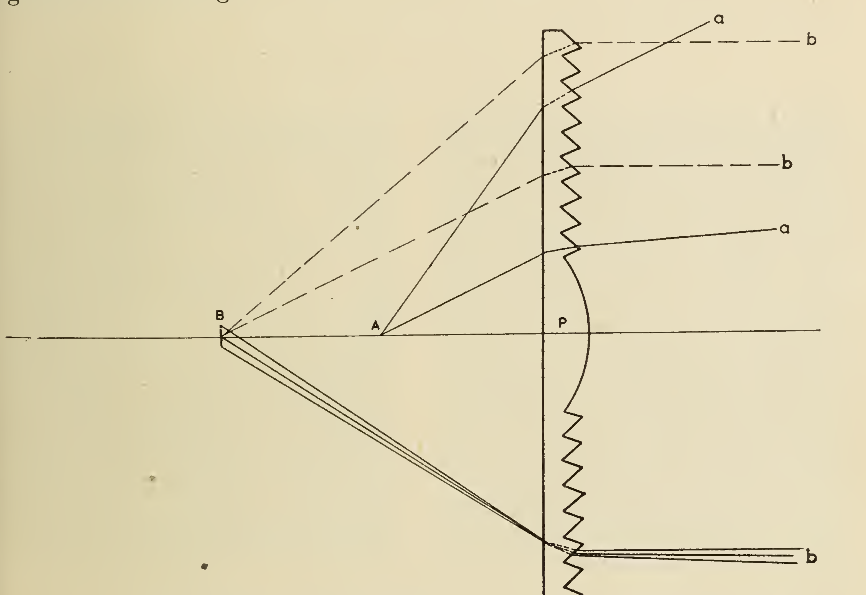


Fig. 6. Action of ideal lens plate

The first compromise which the designer will make is to improve the performance in the " spot " position at the expense, of course, of the wide spread position. This is done by making rays such as Bb_1 less divergent, so that the spot can be made smaller, and affects the spread beam by making rays Ax slightly more divergent. As a result the spread beam will tend to have a dark centre and bright edge ; but this is not bad for with a little cunning it is possible to " pack " the light towards the edge of the light patch (in the spread position) in such a way as to give a comparatively hard edge.

From now on the process of design becomes too involved to describe easily, or indeed to matter for the purpose of this discussion. The designer will examine the fan of light produced by each prism for a variety of lamp positions. The sum effect of all fans in producing a beam must be examined, and small modifications must be made to achieve a good compromise. The process is tedious and involves artistry of design of a high order; nevertheless it can be done with satisfactory results.

Having decided on the angles of the working faces (which may be flat or curved)

of his prisms, the designer must now set out the back faces. In Fig. 8 the working faces of one prism are shown as heavy lines and the back face dotted. Incorrectly placed back faces can give rise to the emission of light in unwanted directions varying from rays emerging almost parallel to the lens face, to rays along the optical axis of the system. A spill ring cuts-off the most widely divergent light, but in some lenses the back faces are blackened with good effect. The disadvantage of this method is the cost involved.

Finally a certain amount of diffusion must be incorporated on the lens, usually on the flat surface. Diffusion is not a means of overcoming bad design but a necessary optical device. Because the lens consists of a series of discrete steps and because (in an incandescent lamp) the source is not a uniformly bright disc, there will inevitably be some lack of smoothness in the beam of light. The diffusion must iron out these irregularities with a minimum of effect on the general beam distribution. Various patterns have been tried and that most favoured at the

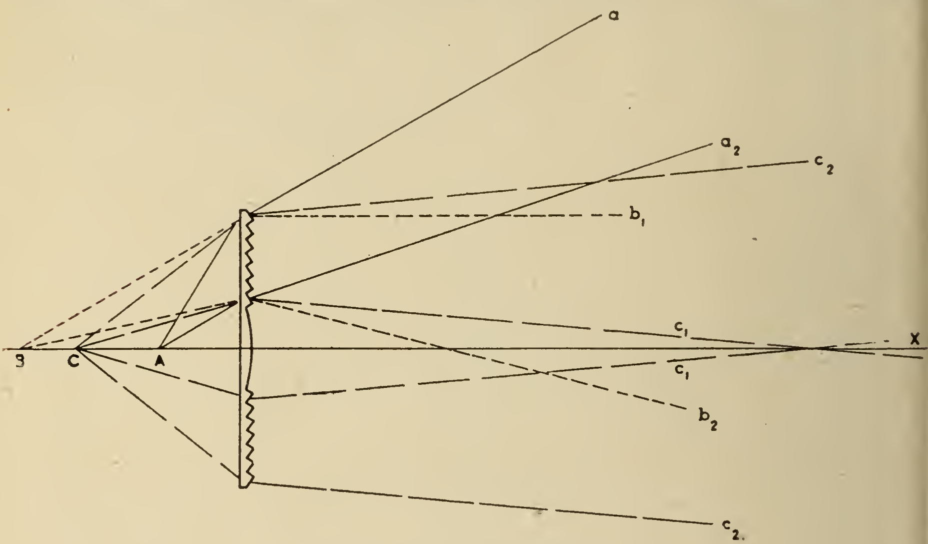


Fig. 7. Rays through lens plate

present is a series of raised knobs on the plate, obtained by forming depressions in the mould from which the glass is made. The exact surface finish of these diffusing knobs is important. Variations difficult to detect by inspection of the lens will produce marked variations in lens performance.

The manufacture of the lenses is a subject in itself and it must suffice to say here that the accuracy of making must be high. An error of 1 degree in prism angle in a few prisms may completely spoil the light distribution.

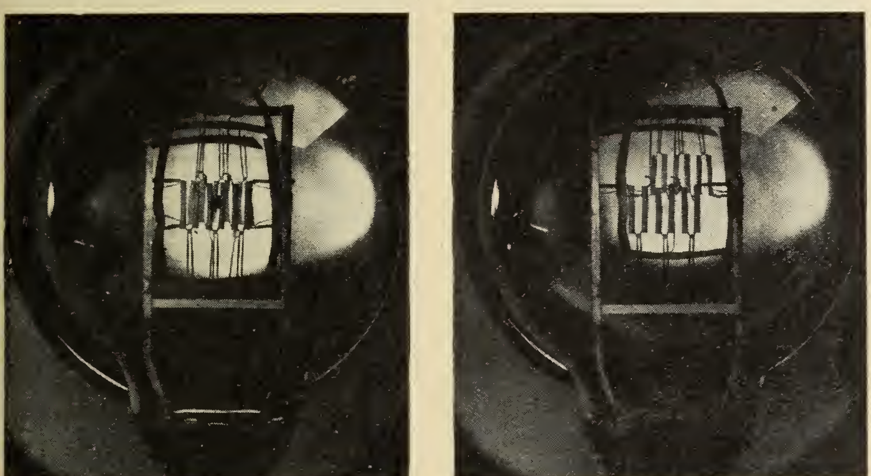
This account of a lens design has been illustrated by reference to a flat lens; but a flat surface is not essential to the design. A curved face although it has no outstanding advantages gives another degree of freedom to the designer, and is used by some lens makers.

With all lens units for incandescent lamps it is customary to provide a backing mirror, spherical in shape, with the lamp at the centre. The mirror should be so arranged that the images of the vertical limbs of the filament mesh with the actual limbs as shown in Fig. 9.

Fig. 8. Prism formation. Working faces, heavy. Back faces, dotted

1.4 Mirror System Illuminators

Mirror systems have gone out of fashion although they are capable of giving results comparable with lenses. One objection to them is that they lead to less convenient mechanical designs than plate lens systems, but another reason for their falling into disrepute may be that early experiments in studios were made with parabolic mirrors. These, which give good concentrated beams, are inherently unsuitable for spread distributions. Suitable mirrors can be made, however, and a simple ellipsoid form gives very nearly what is required. In Fig. 10 if the source is at the focus A of the ellipsoidal reflector, light after reflection will converge to a point P (the second focus) after which it diverges to form a spread beam. If the lamp is now moved back into the reflector rays such as Bx and By become more nearly parallel to the axis (xb_1 yb_2) and a concentrated beam is obtained. It will be noticed that, since in the spot position the lamp is moved into the reflector, more light flux is used in the concentrated beam than in the spread, whereas the converse is true with lens plate systems. This type of mirror arrangement gives, on the whole, a better performance in the concentrating condition than the spread condition but if correctly designed it can give good results over the whole range of distributions and may eventually return to favour.



a b

Fig. 9. Adjustment of spherical backing mirror (a) Well adjusted (b) Badly adjusted

This account of lens and mirror design is necessarily brief: it is only intended to show how such designs are tackled and something of their possibilities. The authors would like to emphasise once again how important it is that the film industry asks if it wants something new. The machinery is ready through the British Kinematograph Society and the British Film Producers' Association, and equipment designers are anxious to co-operate. Let us be sure to remember this in the future.

2. HEAT

Having designed a suitable lens we have to house it in a robust, easy to handle fitting. For convenience the fitting must be relatively small and light even though the energy which it has to dissipate is considerable. We must therefore dispose of the heat, at the same time keeping the body reasonably cool in an efficient way. In the following discussion the principles involved in doing this will be illustrated by reference to lens plate illuminators, although the same principles will apply to other types of fittings.

2.1 Disposal of Heat

The principal method of removing heat from a fitting is by convection and, therefore, the principal point of design is to obtain a good through draught, as free as possible from obstruction, bearing in mind that apertures in the fitting must be louvred to prevent a direct view of the lamp.

If an aperture of good size can be provided at top and bottom of the fitting the hot air surrounding the lamp will sweep up and out, and the maximum rate of heat removal will be obtained. Fig. 11 (*a*) is a photograph of a fitting interior showing heat streams rising, using an efficient louvre system top and bottom. In Fig. 11 (*b*) a baffle plate has been inserted at the top and it will be seen that the hot air sweeps round and down in large eddies, transferring heat to the side of the fitting. Experiments show that cutting holes in the sides of the fittings helps very little in maintaining a smooth flow of hot air : a more important reason for cutting such holes is to reduce the weight of the body.

It must be remembered that openings are required at the top and bottom of the

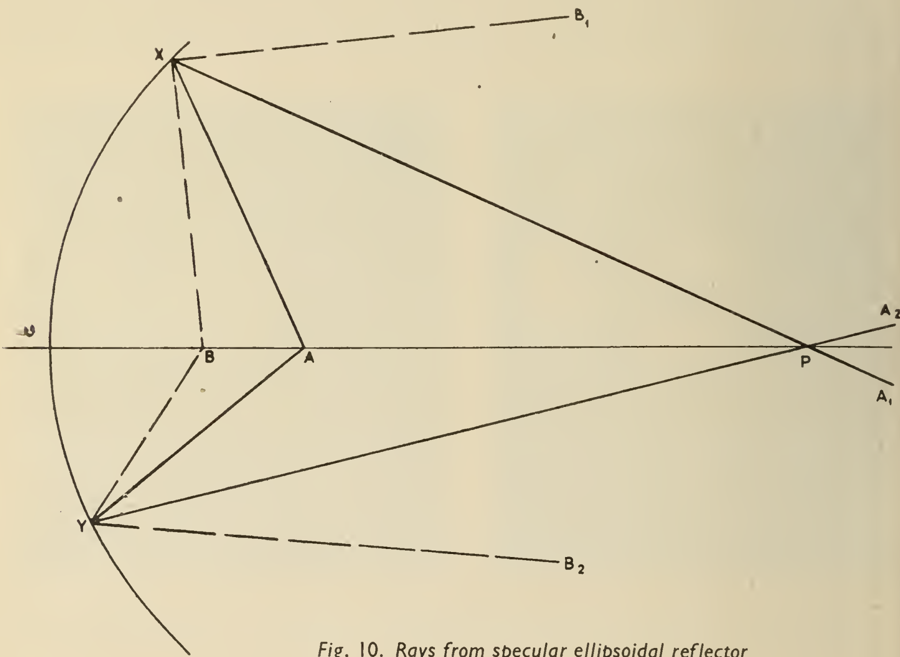


Fig. 10. Rays from specular ellipsoidal reflector

fitting whatever its attitude, so that to allow for tilting downwards it is necessary to have openings in the back of the fitting.

The disposal of heat is complicated in incandescent lamp fittings by the fact that the backing mirror tends to obstruct the convection stream and form a pocket of hot air. The temperature of this air pocket may be so great as to soften the glass of the bulb, which then blows a bubble of glass. Some studios find this so serious a trouble that they remove the backing mirrors in spite of the reduction in light output which results.

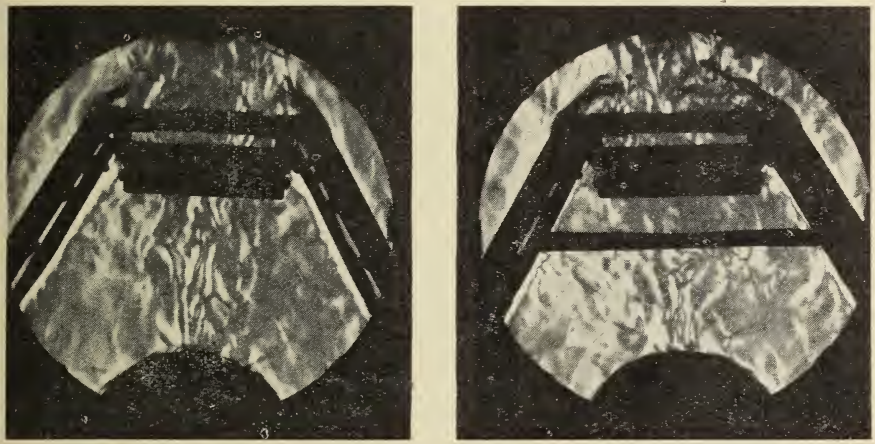
In ventilating an H.I. arc lamp it is useful to arrange that the clean air entering the fitting sweeps up past the back surface of the refractor plate. This helps to keep the refractor plate both cool and clean.

2.2 Temperature of Housing

Removing the heat by efficient convection is only a part of the problem of keeping the body (particularly the control handles) and working parts cool. The most

effective way of doing this is to prevent the heat from reaching the parts in question, that is, by preventing direct radiation from the light source from reaching them. This can be done by making the fitting into a double walled enclosure. In arc lamp units it is usual to lag the space between these walls with heat insulating material. In incandescent units no such lagging is used (since the heat produced by the lamp is relatively small) but it is effective to have the inner (facing) walls polished and the outer wall (facing the open air) painted. The wall facing the lamp must also be painted black to reduce stray light. This double wall construction is shown in Fig. 13 and it is interesting to note that the temperature of the hottest part of the sloping surface near the top of the unit is 60 degrees C. (ambient temperature 25 degrees C.). If the double wall is replaced by a single skin painted black and screwed up to the casting, this temperature rises to 85 degrees C.

In the fitting shown in Fig. 13 the lead screw driving the focusing mechanism is also shielded from direct radiation by being enclosed in a metal tube. This prevents binding due to overheating and obviates the need for frequent greasing.



a b

Fig. 11. Schlieren photograph of air streams in studio illuminator (a) Efficient ventilating system (b) Baffled ventilating system

The construction conventionally used for incandescent lamp fittings consists of an aluminium alloy casting, suitably relieved to reduce weight, and filled in with sheet metal. This construction lends itself admirably to the double-wall requirement as does another with a pressed aluminium body looking almost identical to that shown in Fig. 13. It is interesting to note, however, that one fitting now on the market is a complete break-away from this design. The fitting is made of U-shaped bent metal pieces on the principle shown in Fig. 12. This design leads to a very light weight fitting, but it gets much hotter than the more normal design. It is novel and it will be interesting to know whether the saving in weight proves, with use in the studios, to be worth the sacrifice of coolness.

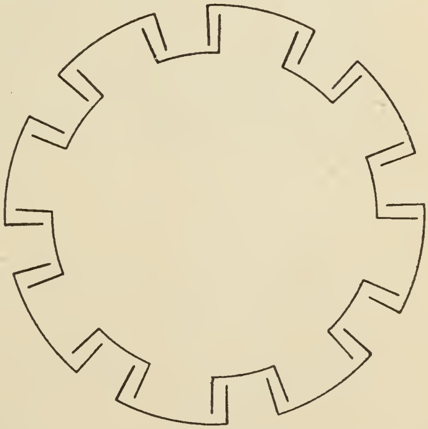


Fig. 12. Principle of sheet metal design : Section

3. SOUND

The first two sections of this paper have dealt principally with the desirable properties of an illuminator, namely, with the light output, and its direction and control. This section has for its subject matter the reduction and elimination of an undesirable feature, namely, the noise which may accompany the operation of a lighting unit. The term " noise " is used to describe any unwanted sound emanating from a lighting fitting, whether it be a note of definite frequency, or a sound having the mixture of frequencies which is usually recognised as a noise.

3.1 Noises arising from Thermal Effects

Noise from studio lighting units may be caused by disturbances of a mechanical

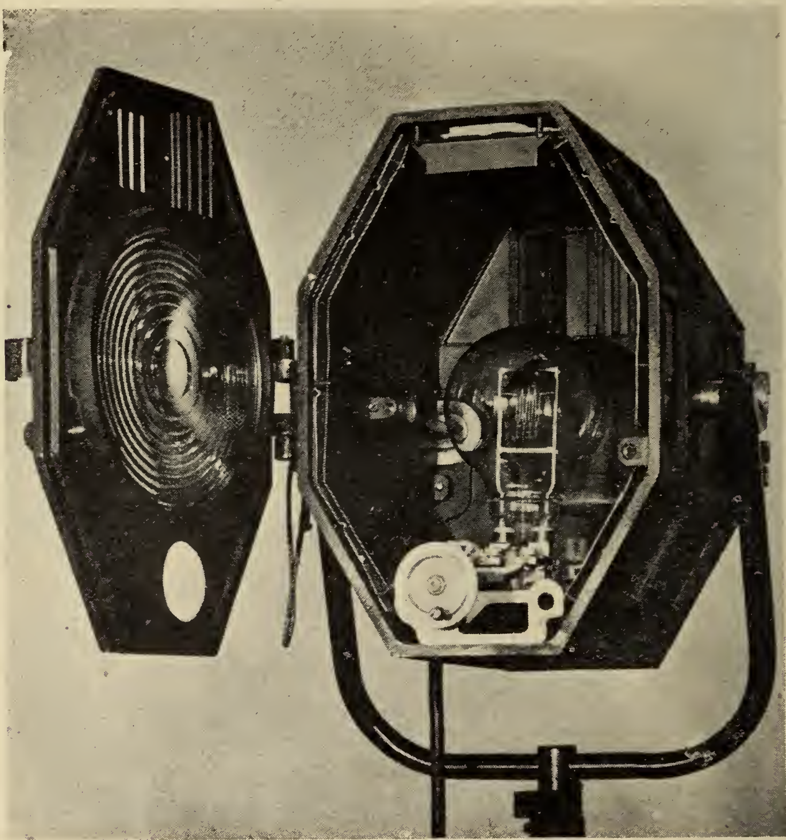


Fig. 13. Illuminator showing double wall construction

or an electrical nature. Mechanical noises can arise from thermal expansion or contraction of the parts of the fitting which change in temperature on switching on or off. They manifest themselves as sudden cracks or ticks when the fitting is warming up or cooling down, and if the sound waves they generate are studied with the aid of a microphone, amplifier and cathode-ray oscilloscope it can readily be seen that although they are of brief duration they have considerable amplitude—the noise is loud while it lasts. Such noises may occur in both arc and incandescent fittings unless care is taken to ensure that there is no relative movement between the various components during thermal expansion or contraction, and that there are no flat, or nearly flat sheets of metal that can exhibit the " oil-can " effect, i.e., jump

with a loud click from one position to another like the bottom of an oil-can when it is pressed.

3.2 Noises Arising from Mechanical Effects

Mechanical noises may also arise from moving parts, such as the feed mechanism of an arc lamp. Rotation of the positive carbon and steady feeding of both positive and negative are essential conditions for the quiet and stable operation of the larger high intensity arcs and these movements are obtained from a small electric motor which drives and rotates the carbons through suitable reduction gearing. Quietness of operation can be secured by the use of well cut, well fitted gearing, and fibre gears have been recommended. It is also desirable to keep the rotational speed of the motor as low as is practical, and to use adequate sound insulation in the mounting of the motor and gearing on the frame of the arc lamp. In the absence of such sound insulation the metal components of the arc lamp act as sounding boards and amplify considerably the noise arising from the motor and gearing. This point is illustrated in Fig. 14, which shows photographs of traces obtained by assessing the noise with the microphone-amplifier cathode ray oscillograph equipment. The first trace shows the noise emanating from a motor and gearbox solidly bolted to the frame of an arc lamp ; in the second trace there is a record of the same motor and gearbox running under precisely the same conditions except that in this case the motor and gearbox are acoustically insulated from the lamp frame.

A further reduction of the amount of noise escaping from the lamp house can be obtained by the use of pads or blankets of sound absorbing material placed in appropriate positions so that they will absorb sound incident upon them, but will not interfere unduly with other functions of the lamp house such as the ventilation and cooling[2].

a

b

Fig. 14. Noise from motor and gearbox of arc lamp feed. (a) Motor solidly bolted to arc lamp frame. (b) Motor acoustically insulated from arc lamp frame

Illuminators using incandescent lamps have no parts which move when the lamp is switched on and so are free from this source of noise.

3.3 Noises of Electrical Origin

The fundamental phenomena which give rise to noise of electrical origin are two in number. The first of these is the flow of electric currents, which is always accompanied by mechanical forces. For example, any two parallel cables in which current is flowing in the same direction will attract each other ; if the current flows in opposite directions—and this is the usual case—then repulsion will occur, and the magnitude of the forces will depend upon the magnitude of the current, the distance between the conductors and their length. Thus in the case of two parallel cables the force between them is given by :

$$F = \frac{2 i_1 i_2 l}{r}$$

where F = Force between the cables.
i_1, i_2 = The currents carried by the two conductors
l = Length of the conductors
r = Distance between the conductors

The second is that no practical D.C. generator will generate a perfectly steady voltage and so there will not be a perfectly steady flow of current unless steps are

taken to remove the effect of the ripple voltage. Indeed all practical forms of D.C. generators are actually rectifiers of A.C. ; the D.C. dynamo is an A.C. generator fitted with a rectifying commutator, and other sources of direct current, such as the mercury arc rectifier, do not generate current but convert alternating current produced elsewhere to direct current. It is a well known fact that the raw output from any form of rectifier still contains A.C. components which if they are not removed will give rise to vibratory mechanical forces in the apparatus which carries the current, and if there is anything free to vibrate in the apparatus as a result of the application of these forces then an objectionable noise will arise. Commutator ripple differs only in degree, not in nature, from the ripples produced by equipment conventionally recognised as rectifiers and can cause vibratory forces to act upon the components carrying current in exactly the same way.

3.4 Production and Silencing of Electrical Noises

Although such vibratory forces act upon illuminating equipment as a result of commutator ripple in the supply, noise will not arise unless parts of the illuminator are free to move. The forces involved are small and so it follows that if the parts are held in position by normal methods of fastening, it is very unlikely that any noise will be generated.

In illuminators using incandescent lamps there is no difficulty in securing the various components against the small forces arising from the commutator ripple, and no noise is found, in practice, to arise from this source.

It is, however, not possible to tie down an arc flame, and moreover, the volume of the flame depends upon the current flowing through it. The arc flame will therefore be influenced by two effects, namely the attraction and repulsion exercised by neighbouring parts of the circuit, and the change in volume of the flame. Consequently it acts as a quite sensitive generator of sound when fed with currents that are not quite steady, and a commutator ripple of quite small amplitude can be heard to an objectionable degree. It is therefore necessary to design D.C. generators for supplying studio equipment to give the minimum ripple voltage, and one British studio generates with a ripple of 0.2 in 230 volts. Even this small ripple however, may be audible ; indeed Duddell[3] claims that under favourable conditions a current ripple of 1/1,000 amps. r.m.s. can be heard, and to remove it filter circuits must be used. These circuits are best discussed after reference has been made to the use of rectifiers.

It has been the custom in this country for the studios to obtain their D.C. supplies either by generation or by conversion of A.C. with the aid of a motor, generator or other form of rotary machinery. Recently, however, interest has been shown in the use of mercury rectifiers, notably of the pumpless steel tank type. It is claimed in a recent publication by L.A. Umansky[4] that rectifiers have a better efficiency than the motor generator when not fully loaded. They give, however, an output voltage which has a ripple much larger than that given by a dynamo, and so their use is conditional upon the fitting of an effective filter circuit. The filters proposed for this purpose are of the well known types ; for example one form employs a series of resonant circuits tuned to the fundamental ripple frequency and its harmonics.

Each circuit consists of a condenser in series with a choke, and they are connected in parallel with each other across the rectifier output terminals, thereby providing a low impedance path for the A.C. components of the rectifier output. A multiphase arrangement of rectifier and main transformer is preferred for this purpose as by this means, the lowest frequency which has to be filtered out may be 300 or 600 cycles per second, and such higher frequencies require a smaller and less expensive filter than would be necessary for the removal of a low frequency ripple, such as one of 50 cycles.

For the removal of commutator ripple, low pass filters have been recommended by Miller[5]. In this type an inductance is placed in series with the load and a con-

denser across it, and the latter provides a low impedance path for all the A.C. components having a frequency above the critical frequency, which is determined by the correct choice of the inductance and capacity.

3.5 Noise Inherent in the Carbon Arc

The sources of noise which have so far been considered all arise from causes external to the arc itself, and would be absent if an arc was powered by a good secondary battery and actuated by completely noiseless feed mechanism.

The arc itself may however serve as a generator of sound, as was first demonstrated by Duddell in 1900.[3] He showed that if a circuit having suitable inductance and capacity were connected in parallel with some forms of arc then oscillations were set up which caused the arc to emit an audible note. The conditions under which this occurs are however special to the experiment and are unlikely to be found in the lighting circuits of a studio.

Many other forms of noise are emitted spontaneously by an arc when it is incorrectly run, e.g., under overload conditions. MacGregor Morris[6] has shown how low intensity arcs will hum and hiss as the current density is increased, and high intensity arcs also emit a characteristic sound if too much current is forced through them, or if the electrodes are brought too close together. But it can readily be shown, by listening to an arc in a quiet room, that neither a high intensity arc nor

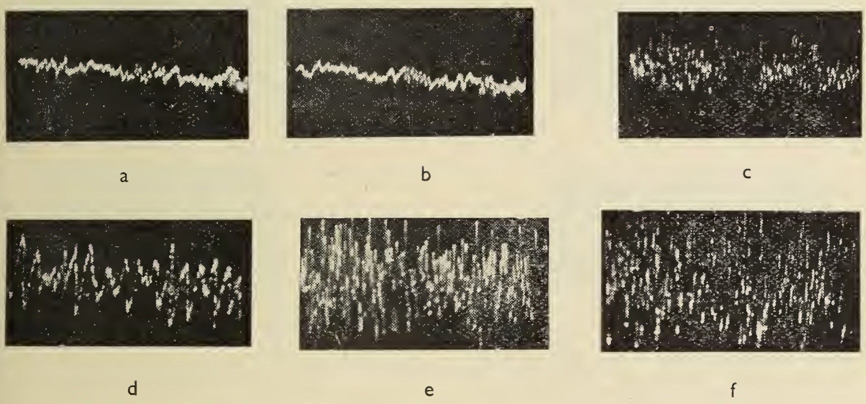


Fig. 15. Noise from single negative arc at various currents. (a) 45 amps., (b) 65 amps., (c) 90 amps., (d) 105 amps., (e) 120 amps., (f) 150 amps.

a low intensity arc is perfectly silent, even when it is set to burn under the most favourable conditions.

The following series of oscillograms (Fig. 15) illustrate this point. They were taken with the same microphone amplifier-oscillograph equipment used for the previous experiments and the traces record the noise produced by H.I. arcs of increasing current burnt at their normal rating.

These oscillograms show quite clearly that the smallest H.I. arc (the 45 amp. arc) makes very little noise, but there is an increase with current, steadily at first, but quite rapidly between 65 and 90 amps. and then again steadily with current up to 150 amps., the highest current at which measurements have been taken at the present time.

The noise has been variously described as a frying or bubbling noise and the references in the literature show that it is well known, and that its origin is ascribed to the negative electrode.[7] Some support for this view can be drawn from a study of the oscillograms in Fig. 15 for it is in the region of 65–90 amps. that there is a distinct change in the composition of the negative flame. It is within the limits of this range of currents that the central white tongue appears and becomes so sharply

defined. It is also within these current limits that the noise increases comparatively rapidly. In view of these observations it seemed to us worth-while trying the experiment of setting up an H.I. arc with two negatives, so that although the current through the positive remains at its usual value the current through each negative is only half of that carried by an arc with a single negative.

3.6 Reduction of Noise Inherent in large H.I. Arcs

The experiment was tried and it was indeed found to be the case that the double negative arc was quieter than the single negative. The oscillograms for a 120 amp. arc are shown in Fig. 16, and for a 150 amp. arc in Fig. 17 and in each case the result is the same, the amplitude of the trace given by the double negative arc is appreciably less than that given by the single negative arrangement, a result that is fully confirmed by listening to the two forms of arc under quiet conditions. It was soon found out however that the reduction in noise obtained by using a double negative was not entirely due to the division of the current between two negatives, for if this were the only factor the noise reduction should be independent of the position of the negatives relative to the positive and to each other. This is not so: the amount of noise made by the double negative arc depends to a certain extent upon the position in which the negatives are placed, the setting shown in Fig. 18 (*a*)

a

b

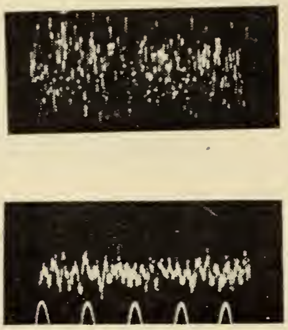


Fig. 16. Noise from 120 amp. arcs. (a) Single negative arc. (b) Double negative arc with 50 cycle timing wave.

a

b

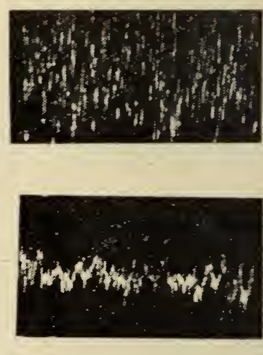


Fig. 17. Noise from 150 amp. arcs. (a) Single negative arc. (b) Double negative arc

giving the quietest burning; other positions, such as Fig. 18 (*b*) are not quite so silent although appreciably quieter than the single negative arc. On the other hand if the negatives are arranged as shown in Fig. 18 (*c*) the arc is almost as noisy as the single negative arrangement*

3.7 Power Absorbed by Double Negative Arc

While these experiments on the noise of the double negative arc were being made another feature of this form of arc began to attract attention, and that was its comparatively low arc voltage. H.I. arcs of 120–150 amps. current when burnt with a single negative have a voltage drop across the arc of 60–65 volts, and it is usual to connect them to the 115 volt mains of the studio in series with a ballast resistance. This absorbs the unwanted volts and as a consequence liberates a good deal of the energy supplied to the lamp circuit as heat. The 150 amp. lamp wastes about 8 KW in this manner. The double negative arc, however, has an arc voltage of only 45–50 volts and is sufficiently stable for two of these arcs to be run in series on a 115 volt main. This makes it possible for two double negative lamps to replace one single negative lamp of the same amperage and its attendant ballast resistance,

* All these measurements of noise were made when the arc was burning without its housing; they represent the full noise of the arc without any reduction that may arise from the sound absorbing properties of the housing.

and so produce twice as much light without drawing any more power from the power-house. There is, as a result of the series connection, a larger proportion of the power usefully expended in the arcs generating light, and only a small proportion used in the ballast resistance, generating heat without light. The exact proportions are shown in Table III.

TABLE III
EFFICIENCY OF ARCS

Single negative arc, one lamp with ballast resistance	
Current 150 amps. Arc voltage 65 volts. Line Voltage 115 volts.	
Kilowatts in arc, producing light	9·75
Kilowatts in ballast generating only heat	7·5
Total Kilowatts . .	17·25
Double negative arc, two lamps with ballast resistance in series	
Current 150 amps. Arc Voltage 49 volts. Line Voltage 57.5 volts per lamp	
Kilowatts in arcs, producing light	14·7
Kilowatts in ballast, generating only heat	2·55
Total Kilowatts . .	17·25

Although, as the above table shows, the amount of ballast resistance is small it has a very important function, for the stability of the twin negative arc, whether two arc lamps are burnt in series or not, depends upon its correct usage. It is essential that each negative carbon should have its own ballast resistance. The schematic diagram, Fig. 19, shows that every negative in each lamp is connected to one terminal of its resistance, the other ends of the appropriate pairs of resistances are connected to each other and to either the negative main, or the positive terminal of the other lamp.

In actual practice these connections are made by means of plugs and sockets which permit two lamps to be run in series, or, in special circumstances, one lamp with an appropriate ballast resistance.

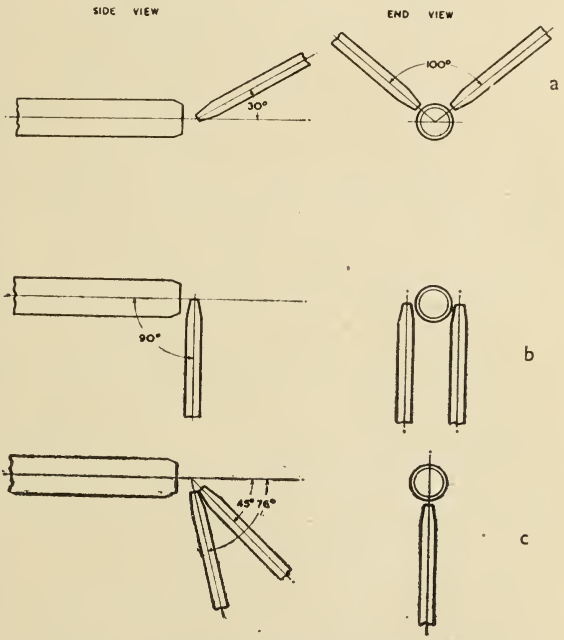


Fig. 18. Effect of different arrangements of negatives on noise produced by the arc (a) Minimum noise. (b) Medium noise. (c) Maximum noise

Another feature of the lamps which helps to secure arc stability as well as cooling is the ventilation system. The air flows in through an opening of generous dimensions in the base of the lamp and is directed by baffles

forward in the direction of the refractor. It sweeps over the surface of the latter thereby ensuring its cleanliness and freedom from arc fume and then leaves through the louvres in the top of the lamp.

The remainder of the bottom of the lamp house is more or less airtight. Such an arrangement permits of the steady flow of a considerable volume of air through the lamp house, thereby securing adequate scavenging and cooling without disturbing the arc flame by involving it in a draught.

3.8 Source of the Reduction in Arc Voltage

Measurements indicate that there is no difference in the light output of corresponding single and double negative arcs, although the voltage drop across the latter arc is about 15 volts less than the former. It is believed that the reason for this increased efficiency arises from a reduction in the power dissipated in the arc flame outside the positive crater when two negatives are used, without any change in the power used inside the positive crater for the production of light. It is apparently necessary to position the negatives so that the negative flames cover the opening of the positive crater in an even manner, and when this is done, a lower

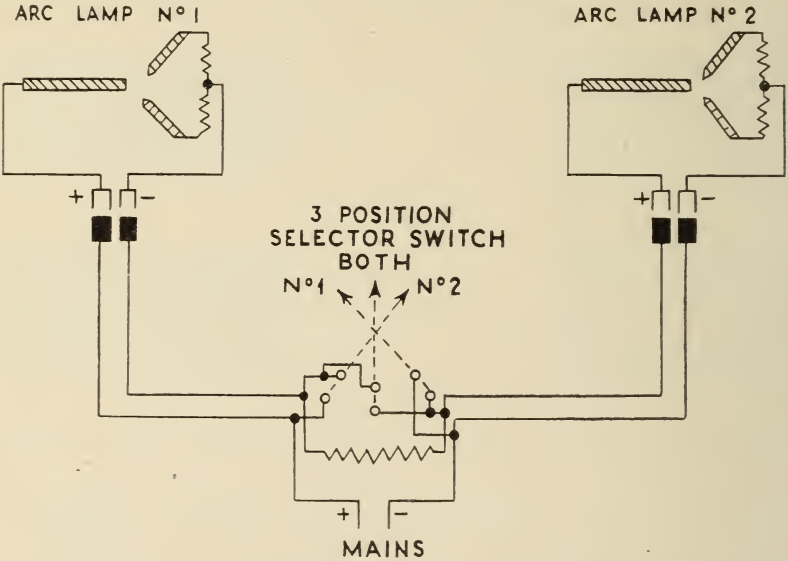


Fig. 19. Schematic diagram of connections for two double negative arc lamps in series, or either lamp and a ballast resistance

arc voltage results. If for any reason, such as misplacement of the negatives, the arc voltage rises, the stability of the arc is reduced and at any voltage greatly in excess of 50 volts, movement and flicker of the flame becomes perceptible. This effect, which in some ways is the reverse of what is found in the single negative arc, is to be the subject of further study.

3.9 Conclusion

The form of high intensity arc described in the later paragraphs of this paper resulted from experiments on the noise inherent in the operation of carbon arcs, and it has consequently first been developed for a use where freedom from noise is of great importance, namely in the studio. Its possibilities in other directions have yet to be explored.

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DISCUSSION

Mr. L. Isaacs : Concerning the angle of carbons, did you try having them pointing up instead of down ?

Dr. Hawkins : Yes, we tried that, and found that pointing downward gives the best results, although a similar upward pointing arrangement is a close runner-up.

Mr. H. Waxman : Is the arc steadier than the single negative arc ?

Dr. Hawkins : When run under proper conditions we believe we can get better stability.

A Visitor : Dr. Hawkins has told us why the arc voltage in a double negative arc is lower. How is the light output affected ?

Dr. Hawkins : Provided the other conditions are the same, the light output is unaffected for the same current and the same positive.

Mr. R. H. Cricks : Some years ago I carried out some experiments on the magnetic control of high-intensity arcs. I found that by correct adjustment of the field, it was possible to work at a lower arc voltage and consequently a higher efficiency, and possibly less noise. Have you tried any experiments in that direction ?

Dr. Hawkins : We have not done a long series of experiments. One hesitates to dogmatise on the effect of magnetic control, but it appears that it has a small effect on the arc voltage of this lamp.

A Visitor : I should like Dr. Hawkins to enlarge on why the negative tip should be the controlling factor in the causing of noises in the arc.

Dr. Hawkins : American studies showed that the hot spot at the tip of the negative was a source of noise, and that by changing the composition of the negative they could reduce that noise. Our observations confirm that. From the oscillograms you will see that the noise grows quite rapidly in the region of 70 to 90 amps—a time when the composition of the negative flame is changing. At lower currents the negative flame is less compressed, as the current rises you get a more rigid flame ; you get an inner tongue which is characteristic of the higher currents.

Mr. L. Isaacs : In regard to the practical working of the lamp, what would happen if you had two dissimilar carbons, with a different burning rate ?

Dr. Hawkins : We have always kept to a nominally identical pair, and the arrangement seems to be self compensatory, if a negative is slow-burning the arc gap will tend to shorten, the current through that negative will tend to rise, and that will make it burn more quickly.

Mr. H. Waxman : Has any thought ever been given to constructing a lamp with a diffusing medium constructed as an integral part of the lamp ?

Mr. Stevens : We have given thought to it, but we are a little afraid to do it. It was one of those things I referred to when I said we are hoping for more co-operation from the studios.

Mr. C. Hillyer : In the design of the lamp, did the designer keep an eye on the maximum weight that it is practicable for us to use ?

Mr. Stevens : Nobody who has spent any time in the studio can fail to know the importance of keeping the weight down. Our mechanical side have endeavoured to do that as far as they can, and I think have made a fairly good job of it.

Mr. A. G. Penny : Looking at these illuminators, it strikes me that they seem to be designed for burning in the horizontal position ; but most of them are used at an angle. Why not design them for the conditions under which they are normally to be used ?

Mr. Stevens : We have tried to make sure that they will function in any position : in particular, we have provided ventilation for burning at any angle.

Mr. H. Waxman : Does the H.I. arc open with the frontal door, or like the 5 kw. ? A problem in trimming the arc is that they are invariably set up above the stage, with an angle of 45°, and they always have to be lined up again.

Dr. Hawkins : It is an interesting suggestion. You have doors on both sides to facilitate re-trimming.

COLOUR TELEVISION

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Read to a joint meeting of the Television Society and the British Kinematograph Society on May 3rd, 1946.

RECENT papers and discussions regarding the future of Television[1] indicate the desirability of a clear understanding of the issues which are important in relation to colour television.

All the systems of colour reproduction so far evolved are based on the splitting up of the colours in the subject into two, or preferably three, suitable primary colours. Experience in the photographic field has shown that three colours are essential to obtain satisfactory results, and the two-colour process has now disappeared, except for advertisements, cheap magazine illustrations, etc., which do not claim to give true colour reproduction.

The Additive Principle

Early attempts at colour photography and kinematography were made by taking simultaneous or successive photographs, through red, green and blue filters, so chosen that they " added up " to white when due allowance for the colour sensitivity characteristic of the photographic emulsion had been made. In the case of still photographs, the print was made by printing on white paper in suitable colours (using " minus " red, " minus " blue, and " minus " green dyes or inks) from the three negatives obtained (e.g., the Carbro process).[2]

In the case of kinematography, either the three negatives were taken at once, each through its appropriate colour filter, and then projected simultaneously through similar filters, the pictures being superposed optically on the projection screen ; or alternatively the separate photographs of the film were taken at an increased speed through a revolving three-colour filter in front of the camera lens, so that successive exposures were made through each filter in turn, and projected similarly. In the latter case persistence of vision allowed the three separate colour pictures to appear as one correctly coloured picture.[3]

All these early attempts at a solution to the problem suffered from one common fault—lack of registration of the colours, producing colour fringes round the image. In the examples cited above, the separate processing and final superposition of each colour primary introduced errors due to film shrinkage, parallax, optical distortion, etc., and the final difficulty of accurate superposition. The case of the film running at increased speed gave a further type of colour fringing on moving objects, where the successive colour primaries were slightly displaced in the direction of motion, due to the motion of the object between each frame of the film. As will be seen later, both types of colour fringe give rise to difficulty when considering methods of colour television, but it should be noted that the latter type can be reduced to an unnoticeable level by increasing the speed sufficiently.

It was not until the advent of the self-coloured film, requiring no special optical/mechanical devices for taking and reproducing, and obviating the registration of the three separated colour images, that colour processes began to gain popularity.

Two basic methods of self-coloured photographic film have been evolved. One is the colour mosaic method, available commercially as the Finlay process, Dufaycolor, etc. The other is the integral tri-pack method, depending on the use of special dye-coupler developers, and available commercially as Kodachrome, Agfacolor, etc. In the former a three-colour mosaic of very fine texture is superposed on the photographic emulsion, which is suitably matched in colour sensitivity

* Research Laboratories of The General Electric Company, Limited, Wembley, England.

to the three basic colours in the filter matrix. The texture of the filter is made fine enough to give no noticeable loss of definition. The photograph is developed as a negative, reversed or printed to a positive, and viewed as a transparency through the colour mosaic—or projected, in the case of kinema film. The filter matrix is a fixture with regard to the emulsion behind it when taking and viewing, so that there is no colour fringing effect, either due to inaccuracies of superposition, or to movement of the subject in the case of motion pictures.

The Subtractive Principle

In the integral tri-pack method of colour reproduction the sensitive film is usually made up in the form of a sandwich of colour filters and colour-sensitive emulsion layers. The film is exposed in the normal way, then developed, reversed, and at a suitable point in the processing, the three layers of emulsion are dyed with special dye-couplers and the silver bleached out. This leaves a transparency in colour suitable for viewing or projection.

This method has the advantage over the mosaic method, of greater transparency and freedom from graininess. The mosaic method is, however, more easily processed, requiring only normal dark-room facilities. Both methods give excellent colour rendering and demonstrate the great improvement which the addition of colour brings to the reproduced picture.

It appears, therefore, from an examination of the development of the coloured photograph and printing techniques, that the following conclusions can be arrived at:

(1) A three-colour system is essential for satisfactory results.

(2) Superposition methods can give rise to objectionable colour fringes of two types: (*a*) those produced by inaccurate registration of the separate colour images when superimposed; and (*b*) those produced by movement of the object between each separate colour frame, in the special case of the kinematograph quoted above.

(3) Self-coloured methods, in which the colour is recorded on the negative and reproduced in the final positive without any physical separation of the three-colour pictures contained in the photographic material, do not suffer from either of the colour fringing defects described in (2).

The Application of Colour to Television

Examination of the literature available shows that all the systems of colour television proposed have a parallel in one or other of the colour reproduction systems discussed above.

Television systems, as such, fall broadly into two classes: (*a*) those dependent on scanning and persistence of vision, and (*b*) those using a direct link between each picture point in the transmitted and received picture, such as banks of photo-cells in the transmitter linked one for one to banks of lamps in the receiver. The only successful commercial television systems so far evolved are of the first type, and it is interesting to note that all the colour television systems so far demonstrated (by Baird,[4] Bell Telephone,[5] and Columbia[6]) are also of this type.

If method (*b*) above were available for television transmission, then the introduction of colour would be a straightforward step, involving treble the number of channels required for a black-and-white picture, each picture point being reproduced by three separate colour channels (see Fig. 1). But such a television system has so far proved impracticable due to cost and complexity of the equipment.

Coming to the methods employing some form of scanning therefore, it will be seen at once that it is not possible to obtain the equivalent of the photographic self-coloured picture, and that the picture is therefore liable to suffer from colour fringes in one form or another, unless a suitable scanning sequence can be found. This is because of the finite time which must elapse between the reproduction of one colour and the next, and the problem is to reduce this time to such an extent that persistence of vision gives the required impression of simultaneity in the colours to avoid colour fringing.

Difficulty of Simultaneous Reproduction

It has been proposed to use three separate channels, one for each colour, with separate camera and receiving cathode-ray tube. It has also been proposed to use separate cameras and/or cathode-ray tubes (beams) for each colour component, switching them sequentially on a common channel.[7] Such systems would be a compromise between the two methods (*a*) and (*b*) above. In this case the difficulty would be to obtain accurate simultaneous registration of the three colour primary pictures in the transmitting cameras and in the receiving tubes.

This brings out a further reason why method (*a*) has so far proved the only successful one both for black-and-white and colour. Electronic cameras and cathode-ray tubes, which are necessary for transmitting and receiving the picture, depend on the scanning of an electron beam, and as workers with cathode-ray oscillographs will readily agree, it is possible to obtain a very high order of relative accuracy with these devices, but absolute accuracy is of a much lower order. When used for television purposes therefore, they give very accurate relative positioning of the adjacent picture points and lines, and it is for this reason that the electronic methods have proved superior to mechanical scanners. Local variations in magnification of the reproduced picture occur, due to non-linearity of deflection, slight pin-cushion or barrel distortion etc., but do not appear critical, even for local displacements of several picture points in magnitude. They would be critical, however, if separate pictures had to be superposed from three receiving tubes (e.g., by optical projection as shown in Fig. 2), and at the present stage of the art it is suggested that any method in which the picture is analysed in more than one camera and synthesised by more than one cathode-ray beam or screen is ruled out of consideration.

Colour Scanning

It would appear, therefore, that if colour television is possible in the immediate future (i.e., without carrying out a major research on any new methods of television recently invented), it must be based on straightforward scanning methods using a single camera and receiver tube in conjunction with suitable colour filters—either fixed or synchronously driven. With this convention the following alternative methods of scanning the complete picture are available :

(1) Scanning each picture point successively in the three primary colours[8] (Fig. 4).
(2) Scanning each picture line successively in the three primary colours[9] (Fig. 5).
(3) Scanning each picture frame successively in the three primary colours[10] (Fig. 6).

Interlacing can be used as found advantageous, and theoretically the same applies to the choice between moving and fixed colour separation filters. Practically, however, it would not appear possible to move the colour filters synchronously at higher frequency than the frame frequency (method 3—see Fig. 3).

If the picture is to be capable of being viewed direct on the face of the cathode-ray tube without the aid of any auxiliary devices such as mirror drums, etc., then the use of fixed filters, of a mosaic or " reseau " type[8] in either method 1 or 2, is ruled out because of the difficulty of accurate registration between the picture on the C.R.T. screen and the required filter mosaic. For reasons stated above, method 1 also suffers from a colour " aperture distortion " due to the scanning spot being of the same order of size as the mosaic elements.

A further factor which must be taken into consideration is that storage in the camera appears to be essential, in order to get adequate light sensitivity, even for black-and-white reproduction. Storage has to be for a number of lines for reasonable sensitivity, and if moving colour filters are to be used, method 3 is the only one which will allow the transmitter mosaic to store a reasonable amount of information in one colour at a time.

It would appear, therefore, that unless some accurate method of registration of a colour mosaic can be contrived, both in the transmitting and receiving tubes,[11] then method 3 is the only possible solution.

American Systems

The Columbia Broadcasting System seem to have come to this conclusion in America. Their papers[6] deal exclusively with this type of system and go very thoroughly into the effect of the various combinations of colour sequence and interlace on such things as flicker and colour fringing in the image.

Of the combinations of scanning sequence examined by Columbia, the one they found most satisfactory is their System 3, with 120 colour fields/sec., 40 colour frames/sec., 60 frames/sec., and 20 colour pictures/sec., interlaced 2/1 (see Fig. 7). They show that this should be reasonably free from flicker and colour fringing defects, up to highlight brightnesses of 2 foot-lamberts. Various observers who have reported on the picture quality to the writer, state that colour fringing was either not present in the demonstrations, because of the choice of slow-moving subject-matter, or was noticeable but tolerable in view of the great improvement given to the picture by the addition of colour.

Experimental Colour Apparatus

An experimental equipment employing this principle has been developed, in order to obtain preliminary appraisal of the relative importance of the parameters involved.* In order to reduce it to the bare essentials necessary for colour reproduction, the transmitter/receiver link was omitted. A cathode-ray tube film scanner, constructed to run 16mm. film at various frame frequencies, in conjunction with suitable line and frame time base generators, was used to generate the picture signals. As a further simplification, the picture reproducing tube was scanned from the same time base generators as the scanning tube (using separate output stages for each).

To obtain colour analysis, special films were prepared by rotating a red/green/blue sequential filter disc in front of the lens of a 16mm. camera. This gave a three-colour separation film (such as was used in the earliest experiments with colour kinematography), the successive monochrome frames of the film containing the red, green and blue information in the pictures, respectively.

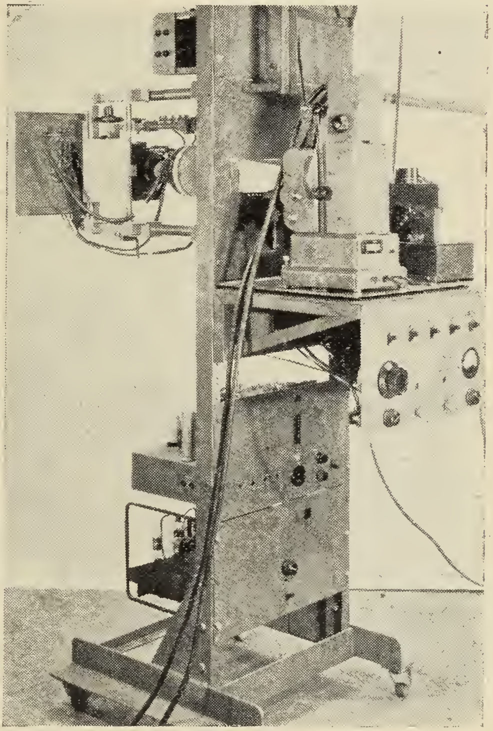


Fig. 8. 16mm. Film Scanner

To reconstitute the colour picture, a similar rotating colour filter disc was revolved synchronously in front of the screen of a white-fluorescing cathode-ray tube. So far, the equipment has only been run at 25 frames per second, 405-line sequential scanning, giving $8\frac{1}{3}$ complete colour pictures per second (see Fig. 6). This resulted in intense colour flicker and fringing, but in spite of this, the presentation of the picture in full colour confirmed the improvement which this gives to picture quality. The next step is to increase the scanning frequency, and then observe if the colour fringing is objectionable.

In the reproduction of monochrome television pictures, three parameters have to be controlled to obtain good tone reproduction : signal amplitude ; background or " black level " ; and gamma, or the relation between brightness ratios in the

* First demonstrated at the Physical Society's Exhibition, January, 1946.

Methods of Colour Reproduction

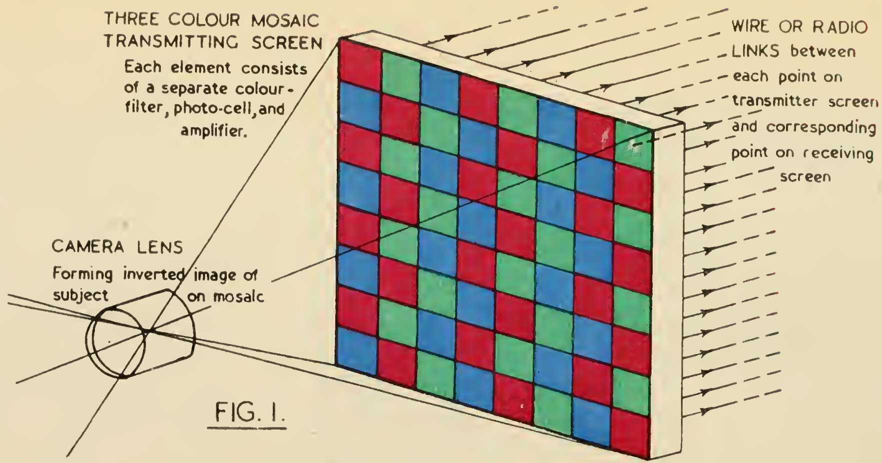
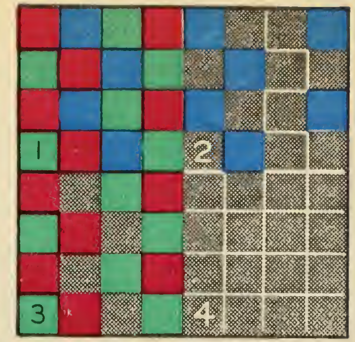


FIG. I.

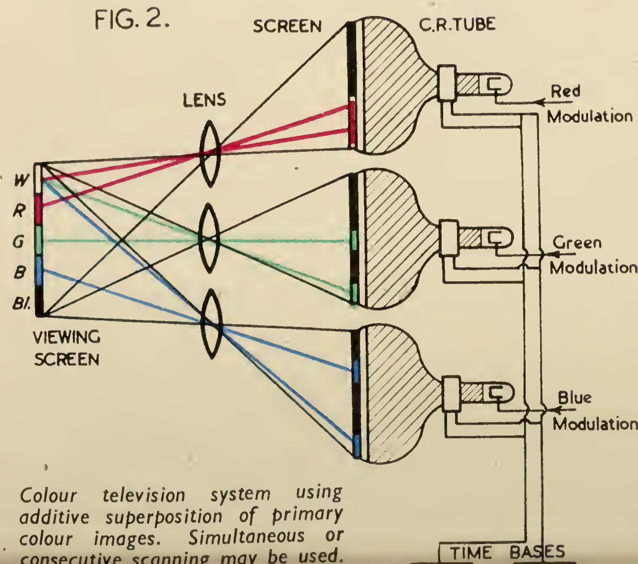
Colour television system not involving scanning.



RECEIVING SCREEN of separate lamps and colour filters connected to appropriate channel from transmitter.

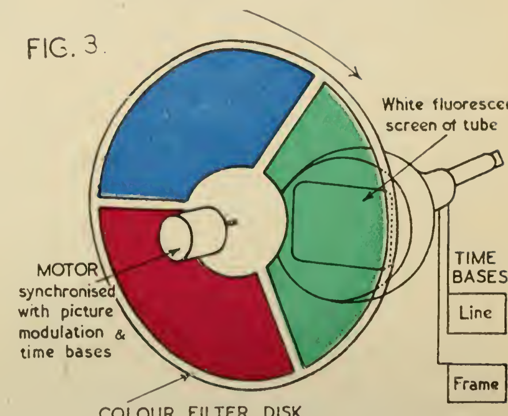
1. *Condition when receiving "white"- all filters illuminated.*
2. *Receiving blue.* 3. *Receiving yellow- (minus blue).* 4. *Black all lamps out.*

FIG. 2.



Colour television system using additive superposition of primary colour images. Simultaneous or consecutive scanning may be used.

FIG. 3.



Colour television system using moving colour filters. Filter colour changes at frame frequency. (Receiver arrangement only shown.)

Methods of Colour Scanning

4

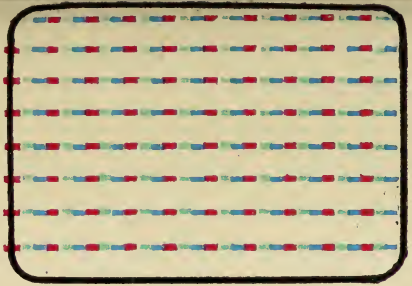


Fig. 4. Scanning each picture point consecutively in three additive primary colours. (8-line picture shown ; 10 picture points per line. Frame and line scan frequency as for monochrome picture).

5

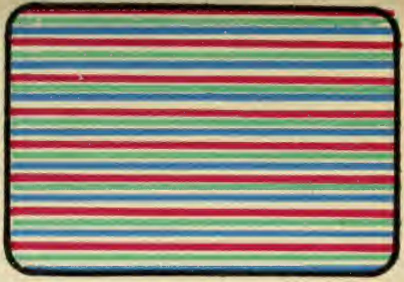


Fig. 5. Scanning each picture line consecutively in three additive primary colours. (8-line picture shown. Frame frequency as for monochrome picture ; line frequency three times monochrome.)

6

Fig. 6. Scanning each picture frame consecutively in three additive primary colours. (8-line picture shown. Frame and line scan frequency two to three times that of same definition monochrome picture.)

7

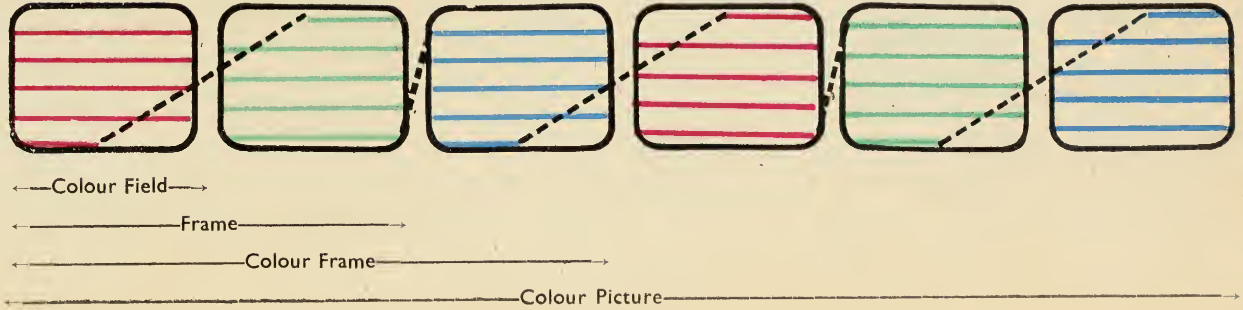


Fig. 7. Modification of Fig. 6, using 2/1 interlace, as adopted by C.B.S.[6] (9-line picture interlaced $4\frac{1}{2}/4\frac{1}{2}$ shown. Colour fields 1 and 4 interlace to give a complete red picture, etc.)

Illustrations reproduced by courtesy of "Electronic Engineering."

original and the reproduction. In a colour system, these three quantities have to be controlled for each of the primary colours, resulting in 9 controls for a three-colour system. The selection of the appropriate control in synchronism with the transmission of the successive colours was effected by means of a mechanical-optical switch* (see Fig. 9). This consisted of a synchronously rotated disc, with 3 sets of 3 slots, operating in conjunction with 9 lamps and 3 photo-cells; the intensity of the light for the 9 lamps was individually adjusted to regulate the light passing from them to the photo-cells, which were in turn arranged to control the three parameters listed above. The slots in the interceptor disc were arranged so that the light from only one lamp from each group of three was operative on the 3 photo-cells at any instant. So far only 7 controls have been brought into operation, 3 each for signal amplitude and black level adjustment, and one controlling the over-all gamma direct.

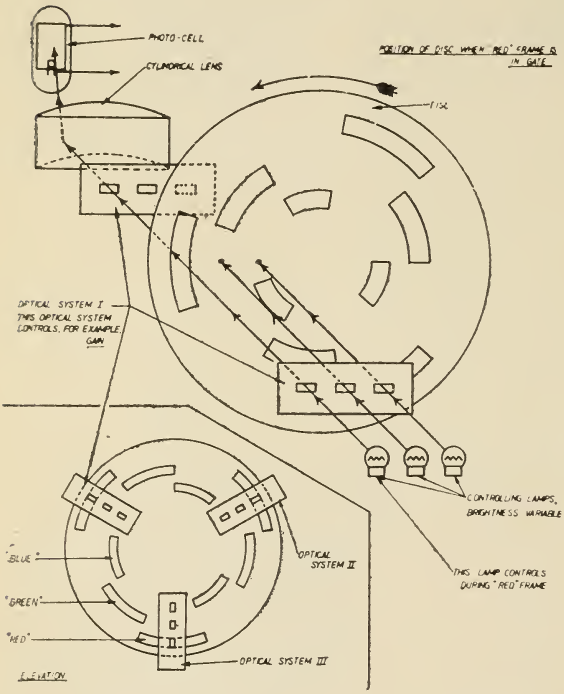


Fig. 9 Schematic Diagram of Colour Control System

Colour Fringing

It is of interest to make a rough calculation of the magnitude of the colour fringes produced by such a system. Suppose a white object is moving across a black background and the reproduced picture is 10 in. (250mm.) wide. Suppose, further, that the white object takes about 4 seconds to move the width of the screen, i.e., travels at about 60mm. second on the screen. Then it will move ½mm. (about one line width on a 400 line picture) between each colour field and if an observer allows his eye to follow the moving object, he will see that the leading and trailing edges have two colour fringes of this width.

A demonstration to show the magnitude of colour fringing consisted of a disc containing red, green, and blue filters in sequence, which was rotated at a suitable speed within a light beam. Due to persistence of vision, the resultant light appeared white, but any rapid movement in the beam caused colour fringing, due to the stroboscopic effect of the continually changing colours; in particular, the rotation of a wheel of white card caused the spokes to appear coloured, while the rim remained white.

Conclusion

Summing up, it appears that until further fundamental developments are made, there is only one method of scanning a colour television picture which is practicable, in the light of present published knowledge and experience, bearing in mind the need for the use of electronic scanners at transmitter and receiver. The basic principle of this method is to scan each picture frame successively in each of the three primary colours. This method is likely to suffer from colour fringing on fast-moving objects, but this price may be worth paying for the addition of colour.

It is desirable to replace the colour filter disc or drum, rotating in front of the

* Pat. Appn. No. 11858/45, G. E. C. and A. E. Sarson.

cathode-ray tube in the receiver, with some more compact, preferably electronic, device, for producing the necessary colour scanning sequence. This may impose certain limitations on the scanning sequences available. The commercial solution of these problems must be achieved if colour is to be ready for inclusion in an improved television system.

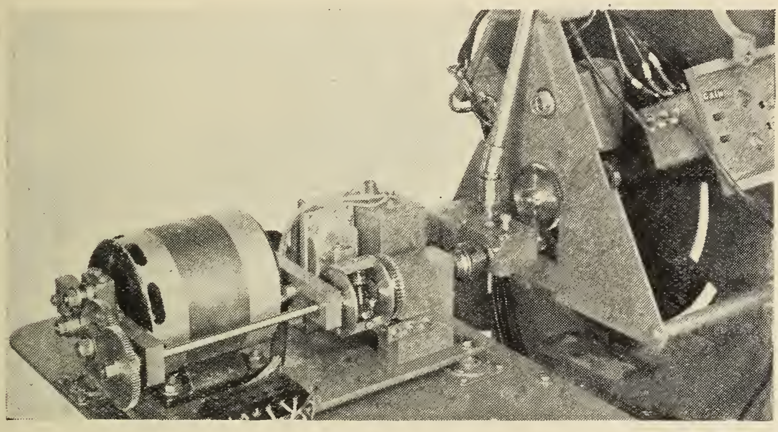


Fig. 10. Colour Control Disc and Main Drive to Film Scanner. Left, Variable Gearing for Frame Frequency Control ; in centre, Differential Gear for Phasing Adjustment, driven by small Motor

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DISCUSSION

Mr. T. M. C. LANCE : A great many people may feel that we are trying to run before we walk. But television is going to be enormously aided by the introduction of colour—far more than the kinema. One of the problems is that of tone range, which is limited partly by the mechanism of the television circuits, and also by the noise level in the transmission. In this case colour is a tremendous asset.

Mr. W. STEVENS : Mr. Jesty suggested three methods whereby we could get colour rendering, but there may be a fourth. It is possible to obtain colouration in Cellophane by means of two pieces of Polaroid. If we could possibly affect the Cellophane by electrical means we might have a means of changing colour electrically, and by putting Polaroid in front of the cathode-ray tube we may have another method of getting our colour without rotating discs. Possibly a Kerr cell, with the property of rotating polarised light, might be used.

Mr. G. PARR : It has already been done. A friend of mine has been doing work on Cellophane from the birefringent point of view, and was telling me about this. He showed me a patent in which the principle of birefringence was used for colour television.

The AUTHOR : In reply I entirely agree on the value of adding colour to the picture. If you go from 400 line television picture to 800 or 1,000 lines you will have an improved television picture, but if you add colour you introduce a new dimension.

With regard to Mr. Stevens' remark, I should like to mention that there are many alternative schemes which have been put forward. for controlling colour electrically. Whilst at the moment we can only see the possibilities of the sequential scanning method, in five years a revolutionary system may be developed.

Mr. A. G. D. WEST : What standards are the Americans using ?

The AUTHOR : Columbia is using 20 complete colour pictures per second, 40 complete colour sequences per second, with a brightness of $2\frac{1}{2}$ foot-lamberts ; the number of lines is 380. The picture is free from flicker, and there is no objectionable colour fringing. By such dodges as following the object with the camera, it should be possible to avoid rapid movement and so avoid colour fringing.

Mr. BOUNDS : The colour fringing appears to be due to the subject moving in the same direction as the colour scanning lines. Possibly the fringing could be reduced by scanning alternate groups of three in opposite directions.

The AUTHOR : Scanning in opposite directions to reduce fringing I do not think would help ; it might even hinder, in much the same way as we have discovered that if you scan coloured film you can sometimes get very much worse colour fringing, because you are bunching the scans together in groups. If you scan three in a group one way, and then three in a group the other way, the gaps between successive groups are increased. Instead of having a series of regular colour fringes you would get probably three smaller ones, then one very big one, which might be more apparent.

With regard to contrast control, I believe the speaker was trying to suggest that if we control contrast in the transmitted signal, we can gain on signal/noise as against random interference. There is considerable argument on this point, in relation to high versus low gamma pictures. It is a case of balancing one thing against another, as the uniformity of brightness in the camera and in the receiver screen have to be of a much higher order. We have found that if you use a low gamma transmission system, you have to achieve a much more uniform screen sensitivity, both in the camera and the cathode-ray tube screen.

AMERICAN STANDARDS SPECIFICATIONS

The following single sheet standards were developed by the A.S.A. Committee on Standardisation in the field of Photography, sponsored by the Optical Society of America.

Z38.1.47–1946	35mm. Film Magazines for Still Picture Cameras, Dimensions for.
Z38.3.3–1946	35mm. Slide film Projection Rolls, Specifications for.
Z38.7.17–1946	Reels for Processed Microfilm.
Z38.7.9–1946	Microfilm Readers, Specifications for.

PROJECTION SCREEN EFFICIENCY

J. L. Stableford (Member)*

Read by Mr. R. Pulman (Fellow) to the B.K.S. Theatre Division on 19th May, 1946.

PROJECTION screen efficiency, in my opinion, means getting the best results out of any combination of apparatus or equipment available at a given moment. I am going to talk mainly about the matt white projection screen, whether it be the so-called rubber or the metal type, although much of what follows will be applicable to any type of screen

By far the greater number of theatres in this country, or throughout the world for that matter, are of such a shape that they call for a matt white screen. This type of screen, being nearly a perfect diffuser, reflects light in all directions within a hemisphere. Since the audience is disposed within a flat ellipse, this is very wasteful. Nevertheless, the matt white screen can give a very pleasing picture, when all factors are in first-class condition.

Effect of Bad Atmosphere

Under conditions of stress during the war, much equipment has been allowed to get into very poor condition. For example, the heater bank might be completely corroded and so, in order to avoid the resulting complaints of draughts of cold air, the fresh air intake is shut right down. Again, owing to the serious shortage of fuel, some theatres have made a practice of shutting down heating systems at about 7 o'clock in the evening. Under either of these conditions, the atmosphere in the theatre becomes excessively contaminated.

This has two effects : the first is the absorption and scattering of the incident ray from the projector. Expert opinion is that under the worst conditions, this loss is as high as 40 or 50 per cent. The second effect is the attack upon the screen by an atmosphere supercharged with tar vapour. The active contaminating agent from cigarette smoking is tar, as the amount of nicotine in the smoke is infinitesimal. The very nature of the screen surface causes it to act as a magnificent absorber. The attack is in its most insidious form, that is to say, vaporised. This is several times more penetrating than a wet application of similar concentration.

Under conditions of considerable neglect, the screen can discolour to the extent of absorbing 40 per cent or more of the incident ray, aggravated by a considerable shift to the red in the spectral response.

Light Losses

Some interesting calculations will show how badly the presented picture will fare with only these two factors being considered.

We will take a projector, as a unit, producing 2,500 lumens forward of the lens. Firstly, there is a loss of 5 to 10 per cent from the porthole glass, depending upon its quality—say $7\frac{1}{2}$ per cent. This leaves 2,312 lumens. Assume a 20 per cent loss by atmospheric absorption through an inefficient plenum or ventilating system and we have a balance of 1,850 lumens. Assume a loss of 30 per cent (not by any means unusual) caused by a dirty screen, we then have a balance of 1,295 lumens leaving the screen. The sorry tale does not end here, however, as the patrons will still suffer a second loss by atmospheric absorption and scattering of the reflected ray. Those at the rear of the theatre will lose 20 per cent, those at the front, perhaps 3 or 4 per cent. One can take the average at 10 per cent ; 10 per cent from 1,295 leaves us with 1,166 lumens. And we started with 2,500 lumens !

Effect of Perforations

Dealing with the provision of a reflecting surface in the form of a screen, immediately there is a light loss of 7 per cent from the sound perforations, although the smallness of this loss might surprise some people who are fond of making the

* Stableford Screens Ltd.

statement that one of the solutions of avoiding light loss is to go back to the old solid screen.

Of the 100 per cent incident ray, the screen is therefore giving back 93 per cent, less the reflection factor. The reflection factor is normally taken as 70 per cent in a brand new screen, but if manufactured with high quality materials, this can be as high as 80 per cent. We have therefore a loss varying between 20 per cent and 30 per cent for the reflection factor—say 25 per cent, making the net return from the screen 69.75 per cent of the incident ray. This, of course, with a brand new screen or an efficiently resurfaced one.

Standard of Reflectivity

Let us see if we can do anything basically to improve the light from the screen. The physical standards of reflection of a diffusing white reflecting plane surface are based, in scientific circles, upon magnesium oxide. Under most elaborate laboratory conditions, it is possible to obtain a reflection factor of 98 per cent of the incident ray. To obtain this, however, it is necessary to burn magnesium ribbon and allow the oxide smoke to collect upon a polished silver surface to a depth of 2mm.

The slightest breath of air will scatter the prepared reflector in all directions and to make such a surface usuable as a projection screen, the particles will have to be bound by a medium. Now, any medium, however waterclear, will degrade quite considerably the reflecting power of the pigment. Under conditions called for in a matt white screen, in the light of present knowledge, there is very little chance of avoiding a light loss through the binder of 10 to 15 per cent.

Causes of Screen Contamination

Many users have no sufficiently clear idea of the processes which bring about screen contamination. We will ignore the mechanical factors of dirt and dust and deal with the main problem, that is to say, discolouration from a smoky atmosphere.

To make a practical test for yourselves, just hold a lighted cigarette in your fingers so that the smoke percolates upwards through them for two or three minutes. You will find that your fingers will be stained yellow. If you try to wash the stain off you will find that soap and water will have very little effect upon it.

Now consider the concentration of smoke in a theatre. Your own living room might be 15 ft. × 18 ft. In this area, with the normal seat concentration of a theatre you would have 30 or 40 seats. Allow for a capacity density of 40 per cent from 12 noon to 11 o'clock at night ; also, realise that most of these people are smoking for a large proportion of the time, and I think you can appreciate the inevitable effect.

Plastic Screens

The Americans have done some experimental work in the newer types of plastics for screens and my own people have also been doing a lot of work in this direction. I say " newer " types of plastics because it does not seem to be appreciated generally that the existing matt white screen is made of nitro-cellulose, which is the mother of all plastics. The newer plastics have certain attractions from the point of view of standing rougher handling, but, once installed, this attraction, of course, ceases to exist.

What we are interested in is the staining from tobacco smoke and it is an unfortunate fact that general experimental work to date indicates that the newer plastic material will absorb tobacco stain and hold it as tenaciously as the nitro-cellulose screen.

Summing up the screen end of film projection, it is clear that, if in the present state of the art, a manufacturer provides the theatre with a screen, the surface of which has a reflection efficiency ranging between 70 and 80 per cent, the remainder of the story is largely up to the theatre.

The Screen an Expendable Item

The writer feels that it is insufficiently appreciated in this country that the screen

must be regarded as a consumable item, just as are carbons and mirrors. There is a shocking tendency here to hang on to the screen to the grim death. This is not so much the case in Canada and the U.S., where the screen is changed much more consistently and frequently. The S.M.P.E. recommendation is that a screen be not resurfaced but changed every year. It is possible to let a screen run for a year in the U.S. and Canada because smoking is not permitted in their theatres, but, from experience over many years of looking after some 1,500 theatres in this country, a six-months' cycle seems to be the optimum period here for screen resurfacing.

In the opinion of the writer, two years is quite long enough to keep a screen in use, as after three resurfacings, however well done, the sound is beginning to be affected to a noticeable degree. It has been the habit in this country to hang on to screens for 5, 6 or even 7 years. From the point of view of sound one might just as well have a piece of linoleum hung up.

Again, some theatres have a chronic complaint of speaker patches, almost always caused through draughts. I call them chronic because very little seems to be done to remedy the real trouble.

Cost of Screen

We will now consider some of the financial aspects of the screen as a consumable item. If a screen costing £37 lasts 5 years, there is a yearly amortisation of £7 10s. od If the screen is resurfaced twice a year at a charge of about £4, annual charges thus become about £15 10s. od., representing 6s. od. per week.

If instead of 5 years we arrange that the screen is changed every 2 years, the amortisation becomes £18 10s. od. per annum. There will be 3 resurfacings in 4 periods, since a turn is missed on changing the screen. Now we have a total amortisation of £24 10s. od. per annum or 9s. 5d. per week.

Thus for the price of one extra seat, the theatre owner has every prospect of the screen being always in first-class condition. Furthermore, the sound deterioration can never be worse than it will be after two or three resurfacings.

When one considers the fact that a theatre spends perhaps anything between £5 and £15 a week on carbons and electric current, according to the type of equipment used, and perhaps £20 to £30 a year on mirrors, the cost of keeping the screen in first-class condition is absurdly low. It is about the cheapest available way of improving the show presented to the patrons. This presentation has to be paid for very heavily by the exhibitor in the form of renters' charges, carbons, current and such things as sound equipment service charges.

A screen is not an item for one to rush and change whenever it happens to be thought about, but should form part of a properly controlled service scheme.

DISCUSSION

Mr. H. C. Stringer: In the silent days we used to have all sorts of directional and semi-directional surfaces. I would like to know whether screen makers propose to introduce this class of screen, as opposed to the matte surface.

Mr. Harkness: Nearly 50 per cent of the smaller theatres are using glass beaded screens; the brightness of the picture goes off at extreme angles.

Mr. R. H. Cricks: May not the many points that have arisen be summarised by the suggestion that screens should be marketed on a more scientific basis? Should not a range of surfaces be available, with different polar characteristics, so that when a screen is installed the characteristics most suitable to the particular auditorium might be chosen?

Mr. H. C. Stringer: No doubt that is the right line, and that involves research in screen technique.

Mr. C. W. Perry: The light from a projector always shows a falling off at the edges. Would it be possible for the screen manufacturer to graduate his perforations from the centre and probably have no perforations at the edges of the screen?

Mr. Harkness: We have tried that; the panels that constitute the screen show up black in the centre and light at the sides.

TECHNICAL ABSTRACTS

Certain of the following abstracts are reprinted by courtesy of Messrs. Kodak Ltd. Most of the periodicals abstracted may be seen in the Society's Library.

RECOVERY OF SILVER FROM PHOTOGRAPHIC FIXING BATHS AND OTHER SOURCES.

R. Fusco, *Chimica e industria*, 24, 1942, pp. 356–358 ; *Chem. Zentralblatt*, Part II, 1943, p. 598.

Referring to the comprehensive work of R. Stratta on silver recovery from exhausted fixing baths, the author describes a new method of treating precipitated silver sulphide with concentrated sulphuric acid by the wet method : $Ag_2S + 2H_2SO_4 \rightarrow Ag_2SO_4 + 4SO_2 + 4H_2O$. Silver sulphate is precipitated with water, and purified by solution in ammonium hydroxide, filtering the impurities, and precipitation with sulphuric acid. The yield is 96 per cent. Further amounts are obtained from the mother liquor by treatment with copper. The very pure sulphate obtained readily yields other silver salts through the oxide or carbonate. The method is also suitable for recovery of silver from silver iodide which precipitates in the preparation of certain quaternary ammonium bases : $2R_4N + Ag_2O + H_2O \rightarrow 2R_4N.OH + 2AgI$, where, moreover, the iodine can also be easily recovered : $2AgI + 2H_2SO_4 \rightarrow Ag_2SO_4 + SO_2 + I_2 + 2H_2O$. (Translation of the German abstract.) W.R.E.

BRIGHT LIGHT SOURCES.

J. N. Aldington, *Trans. Illuminating Engineering Soc.*, 10, January, 1945, pp. 1–22.

A survey is made of tungsten light sources other than household and car lamps. The general characteristics of tungsten filaments operating in a vacuum or in a gas are dealt with first, and then the detailed characteristics of lamps having single and double wound helices, multi-filament lamps and symmetrical sources. R.B.M.

DETERIORATION OF LENSES IN THE TROPICS.

Colonial Cinema, 3, March, 1945, pp. 20–23.

A letter from the Kodak Ltd. Research Laboratories is printed describing the deterioration of lenses and giving advice as to its prevention by dessication of the air, airing, cleaning, avoiding of temperature changes. (Corrosion ; stiffness of movements ; cement " starting " ; mould hyphae.) R.S.S.

NEW METHOD FOR INTENSIFYING THE LATENT IMAGE.

F. W. H. Mueller and J. E. Bates, *J. Phot. Soc. Amer.*, 10, No. 9, November, 1944, pp. 586–591; 704.

The vapours of some organic acids, such as formic, acetic and propionic, exert an intensifying effect upon the latent image, but if applied before exposure, desensitisation is produced. Volatile weak inorganic acids, such as sulphurous acid, have a similar effect. When the acids are dissolved in non-polar solvents, such as benzene, similar effects are obtained. Low and medium-speed emulsions are less responsive than high-speed emulsions, which show speed increases of 200 to 300 per cent with no more than a very slight increase in fog. This method of intensification does not noticeably increase the graininess. The extent of speed increase decreases with the age of the film, and fog is increased with age. When the treated film is held in free air until the acid evaporates, the increase in speed is retained for two weeks prior to development. After 12 to 18 months, films are usually unsatisfactory for latent-image intensification. Minute quantities of water vapour are necessary to the process but aqueous solutions of the acids cause desensitisation. Higher temperatures, reduced pressures, increased concentration, and circulation of the vapour reduce the time of treatment. The possible influence of this treatment on other phenomena, such as low and high-intensity reciprocity-law failure, the Herschel effect, etc., has not been investigated. G.T.E.

TEST FOR EXHAUSTION OF FIXING BATHS.

Photographe, 1943, p. 40 ; *Photo cinéma*, 24, 1943, p. 43 ; *Chem. Zentralblatt*, 114, Part I, 1943, pp. 2472.

To 20 cc. of the fixing bath to be tested are added 3 to 4 drops of a 10 per cent potassium iodide solution. If permanent turbidity occurs, the bath is exhausted. (Translation of the German abstract.) T.H.J.

THE SCIENTIST IN WARTIME—II.

E. Appleton, *Engineer*, 63, November, 30, 1945, pp. 432–433.

A high-speed camera developed at the Road Research Laboratory, Harmondsworth, Middlesex, enables 59 photographs to be taken at frequencies higher than 100,000 per second on stationary film. The camera contains 59 lenses which are exposed by a shutter disc containing a number of slots. The shutter disc is driven at high speed. (A subsidiary shutter isolates a single revolution of the main shutter disc.—Abstractor.)

E.D.E.

PHOTOGRAPHIC RECORDING OF CATHODE-RAY TUBE SCREEN TRACES

R. J. Hercock, R. G. Hopkinson, W. F. Berg, and W. Nethercot, *Phot. J.*, Vol. 86B, No. 6, November–December, 1946.

A series of papers on the recording of cathode-ray traces discusses (1) the requirements of emulsions and developers, (2) fluorescent screen materials, (3) reciprocity failure and pre- and post-exposure, and (4) the photographing of high-speed traces.

R.H.C.

AN IMPROVED FILM DRIVE FILTER MECHANISM.

C. C. Davies, *J. Soc. Mot. Pic. Eng.*, Vol. 46, No. 6, June, 1946, p. 454.

Two types of damped compliance film drive are described, having single and double jockey arms respectively. Electrical equivalent circuits are given together with performance details, and an interesting comparison made with an equivalent damped inertia drive. A new design of sprocket is mentioned in which wider teeth minimise cross-over effect. N.L.

A SIMPLIFIED ALL-PURPOSE FILM RECORDING MACHINE.

G. R. Crane and H. A. Manley, *J. Soc. Mot. Pic. Eng.*, Vol. 46, No. 6, June, 1946, p. 465.

This Western Electric camera incorporates the recently developed double-arm film drive and the film chamber layout is simple and straightforward. It can be adapted for 16mm. film by means of interchangeable sprocket and roller assembly. The driving motor is enclosed within the camera, and a separate compartment houses the unit-mounted light valve, optic, and lamp assembly. N.L.

A SIMPLIFIED RECORDING TRANSMISSION SYSTEM.

F. L. Hopper and R. C. Moody, *J. Soc. Mot. Pic. Eng.*, Vol. 47, No. 2, August 1946, p. 132.

The Western Electrical RA–1253 portable recording amplifier and power pack is described. A straight 3-stage amplifying circuit is employed with a new type of peak limiter using a voltage regulator tube. A noise reduction circuit with the usual controls is included, and details of performance are given. N.L.

SYNCHRONISATION TECHNIQUE.

W. A. Pozner, *J. Soc. Mot. Pic. Eng.*, Vol. 47, No. 3, September, 1946, p. 191.

A survey of early methods of producing foreign language versions of feature films, including the mechanical methods used in Germany, is given. The various stages in the process evolved by M.G.M. International Films Corporation are described, including the projection equipment used, and notes on matching acoustic conditions to visual impressions. N.L.

DUBBING AND POST-SYNCHRONISATION STUDIOS.

W. A. Mueller, *J. Soc. Mot. Pic. Eng.*, Vol. 47, No. 3, September, 1946, p. 230.

The studios built by Warner Bros. to fulfil wartime requirements of foreign language dubbing are described with particular reference to layout and acoustic treatment. Post-war uses include recording of location scenes to guide track, which is now being widely employed in feature production. N.L.

RUSSIAN STEREOSCOPIC FILMS.

J. Polyak, *Red Fleet*, 10th October, 1946 ; S. Ivanov, *Pravda*, 4th October, 1946 ; *Moskovoski Bolshevik*, 19th October, 1946. (Abstracted in the Foreign Office publication *Film News from the Soviet Press*.)

Shortly before the war a system of stereoscopy was developed which did not require any special apparatus to be used by the spectator, and in 1941 it was decided to set up a special studio for the production of films. An improved stereoscopic screen made of glass (?) has been prepared measuring 9 square metres, and a number of films are in production. No stereoscopic films can at the moment be seen. R.H.C.

LECTURES ON OPTICS

IN response to requests from the B.K.S. and members of the industry, the Polytechnic, Regent Street, is organising a third refresher course to follow those being held at present on "Sensitometry and Laboratory Practice" and "The Fundamentals of Sound Recording." The subject asked for is "Optics" and the lecturer is Malcolm V. Hoare, B.Sc. The course is intended for those engaged in all branches of the film industry, who use lenses or other optical equipment and find that an understanding of the behaviour of light would help them in their work.

The course will consist of 10 lectures to be held on Monday evenings from 6–8 p.m. at the Polytechnic, commencing on Monday, 14th April. The fee for the course will be £1 and students should enrol at the Polytechnic on or before that date.

Outline Syllabus

14th April	Light and the Spectrum. Units of light measurement.
21st April	Recording of colour in monochrome. Filters.
28th April	Pola screens. Exposure meters. Measurements of light.
5th May	Basic laws of optics. Image formation.
12th May	Lens systems and focusing.
19th May	Perspective. Factors affecting the length of an image.
26th May	No lecture.
2nd June	Depth of field and depth of focus in theory and practice.
9th June	Errors of lens systems. Coated lenses.
16th June	Basic types of lens systems. Lens testing.
23rd June	Optical systems used in film industry.

BOOK REVIEWS

PHOTOELECTRIC CELLS by A. Sommer (Methuen's Monographs on Physical Subjects). Methuen, 5s. net. 100 pages, 27 Figs.

There is no question as to Dr. Sommer's ability and qualification to write a monograph on photo-cells, as he has been engaged on their development at Cinema-Television for many years. This is an excellent book and summarises the theory and practical points on cells in a very readable manner.

After the historical introduction, the theory of photo-electric emission is explained with the minimum of mathematical expressions, followed by a long chapter on the manufacture and properties of photo-cathodes. The chapter on matching light sources and cathodes, i.e., choosing a cell, is of interest to every user of these universally (but often wrongly) used electronic devices.

The comparison between the gas-filled cell and the vacuum cell is also of particular interest, as is the comparison between the multiplier cell and the plain cell. The final chapter on the applications can only summarise the principal points, but there is a table giving the types recommended for various applications, and the reader is referred to other books dealing with this aspect more fully.

The kinematograph engineer who takes more than a passing interest in the electronic gadget on which his livelihood depends should make a point of buying this book at the very reasonable price of 5s.

G. PARR.

SOCIOLOGY OF FILM by J. P. Mayer. Faber and Faber, Ltd. 328 pages. 15s.

J. P. Mayer has written here a philosophical treatise both ambitious and erudite. It consequently follows that there is a challenge on every page, and enough material for a brains trust to disagree over for an inordinate number of sessions.

It is, indeed, the author's search for esoteric motives for things that can be explained far more simply that is the factor likely to provoke most opposition. "Why do millions go to the picture house ?" he asks in his first paragraph, and quotes psychologists as answering that our modern populus seeks escape from the dreariness and mechanisation of our rationalised lives. But one might equally ask, "Why reading ?" "Why music ?" "Why the arts ?" "Why a deck chair on the beach ?" Is not the short answer this : "Because we enjoy it" ?

He quotes appreciatively another author as saying : "The Elizabethans

were trained listeners ; where we rely on the eye and the printed book, they relied in the ear. . . " He finds this to be a consequence of " the modern rationalised structure of our lives." Surely the superficial reason might be the right one : that the great art form of the kinema happened to be invented in the 19th century and not in the time of Shakespeare. What our entertainment is to be in any generation is surely fortuitous. In broadcasting, for instance, the transmission of sound was invented first. Consequently, people became trained listeners before they became trained watchers of television. The process was reversed in kinematography, not for any profound philosophical reason, but simply because it so happened that invention occurred in that order.

The author describes in his preface how he set out to study kinema. But truly to understand so vast a subject, as to understand a foreign people, one should live with it and them. Certainly this book is, as all good books should be, a challenge to controversy, but many of its conclusions will find many dissenters.

J. C. WARBIS.

ACOUSTICS FOR ARCHITECTS. E. R. Richardson, B.A., Ph.D., D.Sc. (88 *pages*, 29 *Figs.* 7½ × 5 *in.*). *Edward Arnold & Co.* 5*s.*

Some twelve years ago Dr. Richardson published his *Introduction to Acoustics of Buildings* and it is upon this work that the present book is based. The author deals with the general principles of reverberation, resonance, and the behaviour of sound waves. He outlines the various methods of applying acoustic correction to existing buildings, and gives general hints on the acoustic design of auditoria. Some of the author's suggestions for best listening conditions are not altogether in accord with modern thought ; for instance, he states that the difference of the lengths of the possible paths by which sound can reach an auditor from the source should not exceed 70 feet ; some modern authorities have reduced this figure to 45 feet in the case of kinema auditoria, with a possible further restriction where stereophonic sound is employed.

The author, however, seeks to give a general statement of the fundamental acoustic principles, devoid of mathematical complexity, and consequently the book will be found useful to architects and others who have neither time nor inclination to make a close analysis of this complex subject.

L. KNOPP.

DEFECTIVE COLOUR VISION IN INDUSTRY. Report by a Committee of the Colour Group of the Physical Society. Taylor and Francis, Ltd. 3*s.* 6*d.*

A special Committee of the Physical Society Colour Group was appointed in February 1942 with the following Terms of Reference :

" To obtain as complete information as possible as to the technique and processes in which deficiencies of colour vision are a handicap, to report on existing methods of testing such deficiencies in Industry and in Schools, and to make recommendations regarding the improvement and co-ordination of these tests."

A report by this committee has now been published which merits careful study by those concerned with problems of colour perception at the many stages in the production of motion pictures in colour, which begin in the research laboratory of the manufacturer and end in the projected picture.

Eight per cent of the male population have defective colour vision but less than one per cent of women are deficient. Deficiencies in colour sensation are divided into three categories :

(1) Those who possess no colour discrimination, known as *Monochromats.* These are extremely rare.

(2) Those with reduced colour discrimination who can match all colours with two radiations, known as *Dichromats.*

(3) Those who require three radiations for matching all colours but make matches markedly differing from the normal. Known as *Anomalous Trichromats.*

Groups 2 and 3 are each sub-divided into three sub-types. There are three times as many Anomalous Trichromats as Dichromats, the latter being some two per cent of males.

The so-called confusion colours of the colour-blind are green, yellow, orange, red, brown, pink, etc. The most commonly confused colours are red from yellow, and yellow from green—especially in the absence of any brightness difference. Other colours which tend to be confused are blue-green, grey and purple. Usually the defect does not lead to much

difficulty in distinguishing green from blue-green, blue-green from blue, yellow from grey, or grey from blue.

Since persons with defective vision confuse certain colours with one another all tests used for the detection of deficiency are based upon this phenomenon. The Committee recommend as reliable the well-known Confusion Chart Tests for most industries and trades. These tests are composed of a series of cards on which are printed backgrounds of coloured spots the sizes of which are carefully chosen, and interspersed among these background spots are figures, letters, or other shapes, also made of coloured spots of suitable size. These must be recognised in order to pass the test.

The existence of a small proportion of colour deficients in audiences is a matter of no consequence since the appearance of a colour picture which is acceptable to normal vision will closely, if not exactly, resemble the appearance of the world with which the colour deficient is familiar. A dichromat would, however, probably not perceive the closer approximation to truth of the rendering of a three-colour process to that of a two-colour process.

The report makes no mention of the motion picture industry, and the fact that no evidence was obtained as to the proportion of operatives concerned with colour, nor of any tests at present applied, seems an unfortunate omission. Paragraph 6 under Section B (Industry) briefly refers to "Photographic Industries." It is stated that "In photographic colour processes firms report that they deem special tests to be unnecessary, as the number of workers concerned is very small, and colour-weak subjects automatically avoid this work." The reviewer takes strong objection to this statement. Indeed, tests should be regarded as absolutely essential for the following engaged in colour film production :

Studio.—Cameramen ; Directors ; Art directors ; Editors ; Cutters ; Artists, model-makers, painters, costumiers ; Make-up artists ; Title designers and draughtsmen ; Still photographers.

Laboratory.—Graders ; Sensitometric control and testing ; Cutters ; Optical Printers ; Foremen developers and printers ; Viewers in projection department ; Title camera operator.

It would seem highly desirable that the B.K.S. should afford facilities for a test and this would best be carried out by means of, say, the Ishihara confusion charts (9th British Edition), it being advisable that the examinations should be made by someone competent to draw dependable conclusions from the applicants' replies.

The report is the work of some of the outstanding authorities on colour vision in Britain, and the committee members must be congratulated on having made an important contribution to the extensive literature of defective colour vision. It is to be noted that the work was accomplished in London during the war and the Colour Group of the Physical Society have just cause for pride in this achievement. A. Cornwell-Clyne

PERSONAL NEWS OF MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of the Journal.

D. G. Daggett has joined British Tricolour Ltd. where he is working on coloured cartoons.

T. S. Lyndon-Haynes is Assistant Director at Ealing Studios.

Flight-Lieutenant Miller is undergoing a specialised course in photography and kinematography at No. 1 R.A.F. School of Photography.

C. W. Perry has retired from the Ship Carbon Company.

Jack Ramsden has just returned to this country after a survey of India and the Middle East on behalf of British Movietonews Ltd.

C. F. Trippe, since 1927 manager of sound reproducer sales to B.T.H., has retired.

Eric Williams of Ealing Studios has just returned from a visit to Palestine.

R. Gillespie Williams is Vice-President of the Delicolor Corporation, an American company formed to commercialise his new stage lighting system.

EDWARD GODAL

Died 3rd December, 1946

Mr. Godal entered the film industry in 1916, and two years later became interested in the old-established British and Colonial Kinematograph Co., of which he later became chairman and managing director. More recently he had been managing director of British Fine Arts Pictures Ltd., and of Mobile Cinema Services, Ltd., and had been keenly interested in the nearly completed Glenbuck Studios, Surbiton.

THE COUNCIL

Special Meeting of 30th October, 1946

Present: Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), E. Oram (*Hon. Secretary*), P. H. Bastie (*Hon. Treasurer*), C. Cabirol, R. B. Hartley, L. Knopp, A. W. Watkins, A. G. D. West (*Past President*), W. Buckstone (*representing Sub-Standard Division*), B. Honri (*representing Film Production Division*), and R. H. Cricks (*Secretary*).

Fellowship.—Messrs. George Burgess and A. H. C. Rouse were appointed scrutineers in the ballot for the first fifteen Fellows.

Five-year Plan.—Proposals for a five-year plan of progress were received from the following committees:

Theatre Division.
Sub-Standard Division.
Film Production Division.
Education Committee.
Library Committee.
Foreign Relations Committee.
Journal Committee.

Consideration was given to the requirements of staff and finance, and also to an improved system of accountancy. It was agreed that the Secretary should collate the various proposals which should be further considered in detail by the Council.

Meeting of 6th November, 1946

Present: Messrs. I. D. Wratten (*President*), P. H. Bastie (*Hon. Treasurer*), R. B. Hartley, L. Knopp, A. W. Watkins, A. G. D. West (*Past President*), C. H. Bell (*representing Theatre Division*), B. Honri (*representing Film Production Division*), and R. H. Cricks (*Secretary*).

Five-year Plan.—Detailed consideration of proposals for a five-year plan of progress was remitted to a special meeting of the Executive Committee.

Fellowship.—It was decided that the names of those Members elected to the Fellowship should be announced at the general meeting of November 13th.

Library.—Mr. Hartley reported that as a result of his recent circular letter a number of books and donations had been received for the Library. Thanks were conveyed to Mr. Bohm for a book-plate which he had presented.

Film Mutilation Committee.—The President briefly reported the meetings of the Film Mutilation Committee held on the 1st and 23rd October.

Data Book.—The President reported negotiations for the production of a data book. The following committee was appointed to advise on the subject: Messrs. Wratten, West, Knopp, and Honri.

Branches.—At the request of the Theatre Division Committee, brief consideration was given to the constitution, territory and membership of branches.

Membership Qualifications.—It was agreed to instruct the Membership Committee to prepare regulations on the qualifications needed for Membership and Associateship.

Sub-standard Film Division.—It was reported that the Committee of the Sub-standard Film Division had appointed a sub-committee on "16mm. Projection," under the chairmanship of Mr. H. S. Hind, and that the sub-committee on "Film Distribution," under the chairmanship of Mr. W. Buckstone, had been re-formed.

Test Films.—In response to representations from the Sub-standard Film Division, it was reported that the British Standards Institution had obtained 35mm. test films from America, and it was hoped that 16mm. copies of these films could be made in this country.

It was agreed to ask a sub-committee appointed by the Theatre Division Committee to submit recommendations regarding the requirements of sound test films

Leaders and Run-outs.—Representations from the Sub-standard Film Division were received, urging that publication of standards for leaders and run-outs should be expedited.

Co-operation with Trade Unions.—It was agreed that co-operation similar to that existing with the Association of Cine-technicians should be offered to other Unions should they so request.

Journal.—Further consideration was given to the proposal that monthly publication of the *Journal* be instituted.

Meeting of 4th December, 1946

Present: Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), E. Oram (*Hon. Secretary*), P. H. Bastie (*Hon. Treasurer*), C. Cabirol, C. H. Champion, R. B. Hartley, L. Knopp, S. B. Swingler, A. W. Watkins, A. G. D. West (*Past President*), C. H. Bell (*representing Theatre Division*), W. Buckstone (*representing Sub-standard Division*), B. Honri (*representing Film Production Division*), and R. H. Cricks (*Secretary*).

Co-operation with Trade Unions.—Major Bell reported that he had discussed with Mr. T. O'Brien, Secretary of the National Association of Theatrical and Kine. Employees, proposals for co-operation with the B.K.S.

Journal.—The proposal of the Executive Committe, that the *Journal* be published bi-monthly from January, 1947, and monthly from July, was agreed unanimously. The Journal Committee was asked to submit an estimate of cost.

Five-year Plan.—The five-year plan submitted by the Executive Committee was considered in detail.

Papers Committee.—It was agreed that the Papers Committee should be re-elected at the January meeting of the Council and should forthwith meet to plan the lecture session for the 1947–48 session. It was proposed that when the *Journal* was published monthly, notices of meetings might be sent with the *Journal.*

Technical Committees.—The work of the various technical sub-committees of the Divisions was briefly surveyed.

Educational.—Mr. West reported that, as Chairman of the Education Committee, he and the Secretary were shortly attending a meeting at the British Film Producers' Association to consider closer co-operation in the provision of educational facilities.

Branches.—The recommendation of the Executive Committee that the Constitution Committee should prepare a draft constitution for Branches of the Society was accepted.

Film Mutilation Committee.—The President reported that an interim report of film mutilation had been prepared, for submission to the C.E.A. and the K.R.S.

Foreign Relations.—The Vice-president reported that he had contacted the President of the *Association Française des Ingénieurs et Techniciens du Cinéma*, who would welcome co-operation with the Society.

EXECUTIVE COMMITTEE

Meeting of November 6th, 1946

Present: Messrs. I. D. Wratten (*President*), P. H. Bastie (*Hon. Treasurer*), R. H. Cricks (*Secretary*).

Membership.—The following were elected:

Anthony Squire (Member), Anglo-Scottish Pictures, Ltd.
Edward Taylor (Associate), Star Cinema, Blackburn.
John Errol Rankin McDougall (Associate), Associated Screen Studios, Montreal, Canada.
Cyril Ronald George Kirk (Member), Mole-Richardson (England), Ltd.
Leonard John Hewins (Member), Mole-Richardson (England), Ltd.
Basil Tolson Wedmore (Member), Western Electric Co., Ltd.
Allan Alexander Hall (Student), Pathé Pictures, Ltd.
John A. S. Turner (Associate), Pathé Pictures, Ltd.
F. Sellman (Member), Radiant Films, Ltd.
Sidney George Rider (Associate), Merton Park Studios.
Hal Mason (Member), Ealing Studios, Ltd.
Horace George Mason (Member), Hastings-Hodgkins, Ltd.
Dennis Vivian Sumpter (Member), G.B.-Kalee, Ltd., Cardiff.
Peter Noel Bishop (Student), Ultra Radio.
Howard Colin Jones (Student), Polytechnic, Regent Street.
William E. Kelly (Student), Polytechnic, Regent Street.
James Black Sloan (Associate), G.H.W. Productions, Ltd.
Frank Daniel Walter (Associate), M.G.M. British Studios.
Hector Vincent Williams (Associate), M.G.M. British Studios.
Edward Harold Viveash (Associate), Crown Film Unit.
Derrick Edmund Timmins (Associate), Gaumont British News.
Thomas Edward Francis Cadman (Member), G.B. Instructional, Ltd.
Jack Browning Saunders (Member), Unifilm Studio, Ltd.

Frank Trevor Jones (Associate), General Electric Co., Ltd.
William John Hart (Student), Polytechnic, Regent Street.
Krishna Gopal (Associate), Bombay.
Robert Graham Bell (Associate), G.B.-Kalee, Ltd. (Glasgow).
Robert Thomas Trumble (Associate), Gainsborough Pictures (1925), Ltd.
William Frederick Girdlestone (Associate), General Film Distributors, Ltd.
Gordon Salmons (Student), Radio Mechanic, R.E.M.E. (formerly Clifton Cinema, Birmingham).
Arthur Paul Fletcher (Associate),
Derek James Pounder (Student), Polytechnic, Regent Street.
Arthur Frederick Kershaw (Associate), Jones Bros., Ltd., Blackpool.
Rex Eisenstadt Ensleigh (Student), Concord Productions, Ltd.
John Blyth (Associate), The Playhouse, Perth.
Lovat Halket Cave-Chinn (Member), British Paramount News.

The following Associates were transferred to Membership :

James Walker Budge, Scottish Electric, Ltd.
Sidney Robert Deards, Picturedrome, Bedford.
Bertram Sinkinson, English Electric Co., Ltd.
Charles Thomas Parkhouse, Kay Carlton Hill Studios.
Percival George Smith, Regal Cinema, Torquay.
Allan Terence Sinclair, RCA Photophone, Ltd.

The following Student was transferred to Associateship :

Anthony Frank Hinds, Exclusive Films.

The following resignation was accepted with regret :

F. W. Hirst (Associate).

Deaths.—The deaths of the following were recorded with regret

J. Hutchins (Member).
R. Ingram (Associate).
E. Lauste (Member).

Special Meeting of 20th November, 1946

Present : Messrs. I. D. Wratten (*President*), P. H. Bastie (*Hon. Treasurer*), R. H Cricks (*Secretary*).

Journal.—The desirability of monthly publication of the *Journal* was fully agreed. It was suggested to recommend to the Council that bi-monthly publication be instituted from January, 1947 and monthly publication from July. Other activities of the Society should, if necessary, be reduced to a minimum to make such publication possible.

Five-year Plan.—Draft of a five-year plan of progress was agreed for submission to the Council.

Branches.—It was agreed to recommend to the Council that the Constitution Committee should be asked to prepare a draft constitution for Branches.

Awards.—Mr. Wratten reported that a member of the Council who wished to remain anonymous had offered to present a gold medal for the best paper read to the Society, or published in the *Journal* during Mr. Wratten's term of office.

Meeting of 4th December, 1946

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), P. H. Bastie (*Hon. Treasurer*), R. H. Cricks (*Secretary*).

Elections.—The following were elected with effect from July, 1946 :

Raymond Albert Mustow (Associate), Mole-Richardson (England), Ltd.
Desmond Cockburn Dickinson (Member), D. & P. Studios.
Norman Alfred Prouting (Student), Polytechnic, Regent Street.
Frank Charles Littlejohns (Associate), Technicolor, Ltd.
John Lennox Kincaid Hall (Associate), Technicolor, Ltd.
George Hirehouse Newton (Associate), Technicolor, Ltd.
John Alfred Clark (Associate), Denham Laboratories.

The following were elected with effect from January, 1947 :

Cyril Jack Phillips (Member), Pathé Pictures, Ltd.
John Francis Gooding (Associate), Universal Car Co., Ltd.
Albert John Graham (Associate), Cinetechnic, Ltd.
Richard A. Smith (Member), Merton Park Studios.
John Denton (Associate), Princes Theatre, North Shields.

Albert Charles Hammond (Associate), Merton Park Studios.
Guy Spencer Baker (Member), Paramount Pictures Theatre Circuit.
Frederick Edwin Bowles (Associate), Ernest F. Moy, Ltd.
Miss Elfra Lorraine Prideaux (Associate), Religious Films, Ltd.
John Charles George Speller (Member), Ealing Studios, Ltd.
Harold Herbert Hooper (Associate), Film Producers' Guild.
Darrel Charles Catling (Member), G.B. Instructional, Ltd.
Charles Edwin Perry (Member), Odeon Theatres, Ltd.
Leslie Horace Edwin Dunk (Associate), Pathé Pictures, Ltd.
John Gordon Doncaster (Associate), Kay Film Printing Co., Ltd.
Colin Bell (Associate), G.B. Instructional Films Ltd.
Leonard Reginald Joffre Johnson (Member), Cinema-Television, Ltd.

Transfers.—The following Associates were transferred to Membership :
Eugene Hague, Technicolor, Ltd.
Adolph Iredell Morgan, Ministry of Supply.
Donald William Aldous, Walden Films, Ltd.
Gordon Alexander D. Rennie, Pathé Pictures, Ltd.
Harry Smith, Ilford, Ltd.

Resignations.—The resignation of Mrs. Powell was accepted with regret.

Fellowship.—The names of Fellows elected at the meeting of the 13th Novembe were noted. (See p. 721 of the October–December *Journal*).

THE JOURNAL OF THE
BRITISH KINEMATOGRAPH SOCIETY

Vol. 10. No. 2. MARCH and APRIL, 1947

LECTURE PROGRAMME, 1947/8

The Papers Committee is arranging the programme of meetings for the 1947/1948 session, and is open to consider proposals from Members who may be prepared to read a paper at either the Society or Divisional meetings.

The proposal should be accompanied by a synopsis giving sufficient detail to enable the Committee to determine whether the paper is suitable for inclusion in the forthcoming session. The proposals should reach the office of the Society not later than 25th April, 1947.

Information for the guidance of authors in the preparation and submission of papers is obtainable from the Secretary on request.

Attention may, however, be drawn to the Committee's decision that Society Meetings will be of a higher scientific and technical character than hitherto, and that Divisional meetings will be of a more popular and demonstrative nature.

L. KNOPP,
Acting Chairman, Papers Committee.

PHYSICAL SOCIETY EXHIBITION

This exhibition, which is being held this year in the Department of Physics, Imperial College, South Kensington, on the 9th, 10th, 11th, and 12th of April, usually attracts a large number of visitors.

The B.K.S. is arranging an exhibit showing some examples of motion picture equipment as used for scientific research. In addition some examples from research films are being shown on the screen. The Physical Society has provided us with the Small Lecture Theatre for this display and members of the B.K.S. and their friends have loaned the special equipment which is to be shown.

Our Society is performing one of its proper functions in sponsoring this exhibit, and as a result we can expect an increased interest in the use of the motion picture among research workers.

There is a need for volunteers to assist and in particular we require members who can spare a little time during the period of the exhibit, and are able to discuss the possibilities of the motion picture with visitors. A rota of B.K.S. members who can attend during the four days is being prepared by the Secretary and those able to help should get in touch with him as soon as possible.

The B.K.S. has only a small number of tickets and these will be available to helpers.

W. BUCKSTONE.

Members are requested to note change of telephone number to
GERrard 1154/5 (2 lines).

AUDITORIUM REQUIREMENTS IN SOUND FILM PRESENTATION

The Theatre Division Committee appointed two Sub-committees to prepare reports on the requirements of auditorium design, from the aspects of picture projection and sound reproduction respectively.

I.—PICTURE PROJECTION

R. E. Pulman (*Fellow*),* J. L. Stableford (*Member*),† and H. P. Woods (*Member*).‡

Read by I. D. Wratten, F.R.P.S. (Fellow), to the British Kinematograph Society on March 13th, 1946, and by Mr. Pulman to the Newcastle-on-Tyne Section of the Theatre Division on January 7th, 1947.

THE presentation of kinematograph sound films in auditoria has been made possible by the use of scientific phenomena which can be perceived by the senses of sight and hearing.

It would be reasonable to suppose that those concerned in the design of auditoria would have given due consideration to the physiological requirements of the eye and ear mechanisms so that both might receive the intelligence conveyed to them by sound films in conditions of reasonable comfort, but, unfortunately, such procedure does not seem to have been the rule in the past. It would be difficult, and perhaps unfair, to attempt to apportion the blame for this lack of consideration, for kinema architects and engineers are not physiologists, and if their past endeavours have not appealed to those learned in physiology, then perhaps the latter might have been expected to tell them why. It may be that the physiologists are not at all certain what minimum standards are desirable.

This paper deals only with the effect of sound films on the organ of sight, and the authors must therefore confine themselves to the problems of generation and transmission of light in so far as this is used for the projection of kinematograph films. They wish to emphasise, however, that in the absence of acknowledged physiological standards for such work they do not seek to set up such standards, but merely to review suggestions made in this and other countries, and to relate these to the performance limits of kinema projection equipment.

Standardising Screen Brightness

The fact that a committee of the British Standards Institution, dealing with one of the most important aspects affecting this subject, *i.e.*, desirable limits of kinema screen brightness, has resumed deliberations interrupted by the outbreak of war, might be advanced as an argument that the authors are premature in putting forward this paper, and that consideration should be deferred until some authoritative standard of screen brightness is available. But their reply is that, first, it may be some considerable time before a B.S.I. standard can be set up, if we appreciate the difficulties involved which were quoted by E. Oram in an address to this Society on the occasion of the inauguration of our Theatre Division[1]; secondly, despite the probability that kinema building and re-building, apart from special cases, may continue to be prohibited for two years or even longer, it is undoubtedly the case that much

* G.B. Picture Corporation, Ltd.
† Stableford Screens, Ltd.
‡ Ship Carbon Co. of Great Britain, Ltd.

design work is in hand ; thirdly, it is believed that, in many kinema theatres, existing very poor physiological viewing conditions could be improved in greater or lesser degree if more information were made available to those concerned ; and, lastly, it is thought that sufficient information is available and can be summarised to indicate, even within broad limits, the conclusions likely to be arrived at by the B.S.I. Screen Brightness Committee on that particular problem.

Six Essentials

The authors submit that in the design of kinema auditoria, the architect and the engineer (and the work of both is of equal importance) should have regard to six main points so as to ensure :

1. Clear vision of the entire picture area from every seat.
2. Minimum distortion of the picture image both in projection and in viewing.
3. Auditorium dimensions suited to practicable picture area.
4. Provision of adequate and consistent screen illumination with proper distribution over the picture area.
5. Carefully arranged surroundings to the picture area.
6. Correct choice of screen.

1. CLEAR VISION OF PICTURE AREA

The first item, that of clear vision of the picture area from every seat, may appear at first glance to be too obvious to be worth mentioning ; nevertheless, it is surprising to find in some of the most modern super-kinemas that the seat spacing arrangements are such that a full view of the picture area is restricted by the heads and shoulders of those sitting immediately in front. This is a matter for the architect, though his possible solution of more steeply raking the seating may well be negatived by the engineer's requirements in connection with the angle of projection (to be dealt with later), so that some compromise may be necessary. But this question of clear vision is one which deserves close attention, since the goodwill of kinema patrons may be adversely affected.

The authors feel that insufficient attention has been paid to the proper planning of seating. If the seats are scientifically staggered it will enable the ramp angles to be reduced by nearly one-half, and yet still give unhindered viewing for each patron. This has more important advantages than would at first appear. Obviously, it eases the constructional problems, but more importantly, it can be of great help to the sound engineers.

Volume of Auditorium

Although this paper is not intended to deal with the latter aspect, it may perhaps be permitted to make an observation which is relevant to projection problems. Acoustic engineers are constantly dealing with the problem of reverberation, and excessive cubic capacity makes it difficult to keep this within acceptable limits.

The ideal to aim at is thought to be approximately 120 to 130 cubic feet per seat. A steep ramp and a high dome will increase the cubic capacity much above this figure, so that with a shallower ramp, the architect is enabled to keep the height, and thus the cubic capacity of his auditorium, very much reduced.

To be perfect, it would be necessary to stagger each seat directly in relation to its position, but this is quite unnecessary, and group staggering for various parts of the auditorium can be arranged without great difficulty.

One objection to staggered seats is the serrated gangway which would be produced, of which the Authorities may disapprove. It should not be difficult, however, to attach to the flanking seats a tubular iron member which would

have the effect of keeping the gangway a straight line.

If the scientific aspect of staggered seating is taken to its conclusion, it will be found that in many cases the auditorium floor could have a negative ramp for the first rows of seats, thus again reducing the high ramp and cubic capacity problems.

2. MINIMUM DISTORTION OF IMAGE

The second item, that of providing for minimum distortion of the picture image, both in projection and viewing, requires the projection enclosure to be centrally disposed to the screen in both horizontal and vertical planes, with the projector mechanisms mounted accordingly. Assuming, as is usual, a strictly perpendicular screen surface, a line joining the centre of the film mechanism gate and the centre of the screen should be at right angles to both, or, as it is usually termed, the projection angle should be zero degrees.

This, given correct projector working conditions, provides distortionless projection of the image, but is an ideal which is impossible in practice, since two projectors at least are required, and additionally it is usually necessary

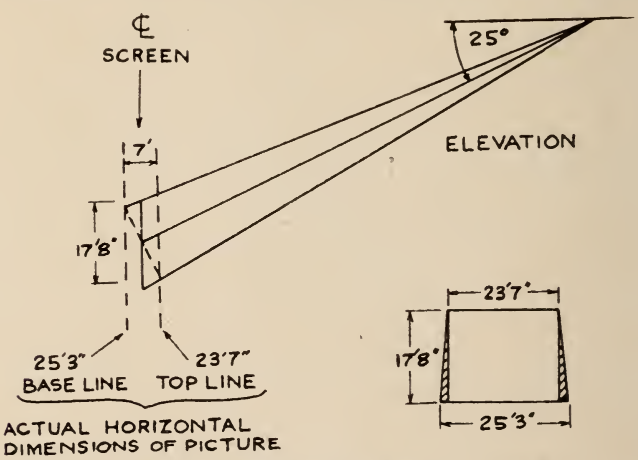

Fig. 1. Effect of Projection Rake, illustrating "out-of-focus" and "keystone" effects.

to site the projection enclosure well above a line drawn at right angles to the screen centre. The projection angle in the vertical plane then becomes negative, but distortion from this source is reasonably slight and hardly discernible up to about 12 degrees ; however, with an increasing negative angle above this figure, distortion rapidly becomes intolerable. Such a projected image as viewed on the screen is never a rectangle, but a trapezoid, and if the projection angle in the horizontal plane is other than zero the shape changes to a trapesium, introducing distortion in two planes.

Even if the Licensing Authority would permit the siting of the projection enclosure under and to the front of the circle, thus providing both a zero projection angle and better facilities for improved rake of seating, this would not necessarily be a satisfactory solution, because, contrary to general belief, the distance from projector to screen can be too short, involving the use of projection lenses of very short focal length, which has certain technical disadvantages. The authors suggest that the length of the projection beam, or throw, should be not less than 4.7 times the picture width.

Projection Rake

The authors would like to offer a basis of discussion on projection without

rake. It is not popular, perhaps chiefly because its practical difficulties have not been solved.

To produce a flat rake, almost inevitably it means that the projection enclosure must be at the back of the stalls and the ray just clear of the bottom balcony. This produces two drawbacks : firstly, it interferes with the disposition of the entrance hall or foyer, and secondly, the light ray suffers more than ever from absorption and reflection by smoky atmosphere. The former is a problem for the architect to solve, and the latter might be eliminated largely by trunking carried from the balcony, enclosing the ray and slightly pressurised. So that the apparent height of the balcony is not reduced this trunking could be of transparent material, such as Perspex. We know this type of projection has been tried in a number of kinemas and has not proved popular, but only because the above drawbacks have not been dealt with.

One possibility would give a projection enclosure and rewind room under the balcony level and in order to give side entrances to the stalls, the rectifier room, battery room, and rest room could be placed on a second floor of a self-contained suite.

In a kinema with an admittedly high rake of 25 degrees and a picture 24 feet in width, the top is focusing 7 feet in front of the bottom of the picture. With a more normal rake of 15 degrees this distance is 5 feet. With no rake the picture would focus all in the same plane. With 2 degrees or 3 degrees positive rake the displacement would be only 9 inches.

3. AUDITORIUM DIMENSIONS IN RELATION TO SCREEN

The third requirement, that auditorium dimensions should be suited to the practicable picture area, is very important from the physiological angle. There must, of necessity, be some relationship between the picture area and the maximum and minimum distances from the screen to the viewer. If this distance is too great for a given picture area, the viewer will find difficulty in observing detail ; if the distance is too short the eye is unable to focus on its retina the full picture area, and physical movement of the eye may be required to follow the movement of the screen characters. The bad effects on both eye and brain in such conditions are well summarised by Dr. D. T. Harris in an address to this Society[2].

While not putting forward any recommended minimum distance between screen and viewer, Dr. Harris suggested that the maximum distance should be 6.0 times the picture width, and this figure is only a little in excess of the figures of 5.2 to 5.8 recommended by the Society of Motion Picture Engineers of America. For the minimum distance the S.M.P.E. suggests a factor of 1.0 as the relationship between picture width and distance of the nearest seat, and this figure fits in very well with a requirement imposed by the London County Council and other licensing authorities, and designed to prevent eyestrain arising from too close a proximity to the screen. Taking the more favourable of the suggested maximum distance factors, 5.2, a viewing angle of about 11 degrees solid angle from the most distant seats results, while the solid viewing angle from the nearest seat, accepting the factor of 1.0, is found to be about 54 degrees.

From a study of vision threshold and the visual angle for binocular vision, these figures allow for comfortable viewing conditions.

Viewing Angle

This conclusion, however, is for seats on the centre line of the screen or subtending an angle of not more than 10 degrees. Outside this angle distortion is apparent and is at a maximum at the extreme ends of the front row of seats. Dr. Harris suggests that seats in these positions should subtend an angle of

not more than 30 degrees with the centre line of the screen, and that the width of the rear row of seats be not more than six times the picture width, but he stipulates that the 30 degree maximum should be used only with good illumination and a good diffusing screen. (Fig. 2.)

Theoretically, the ratios which have been suggested would seem to impose no limitation on auditorium size, but this is not the case, as will be seen by an examination of the fourth requirement calling for the provision of consistent and adequate screen illumination with proper distribution over the picture area.

4. ADEQUATE PICTURE ILLUMINATION

At the present time the normal source of illumination for standard kinematograph projection is the carbon arc. This source of light has a wide range of

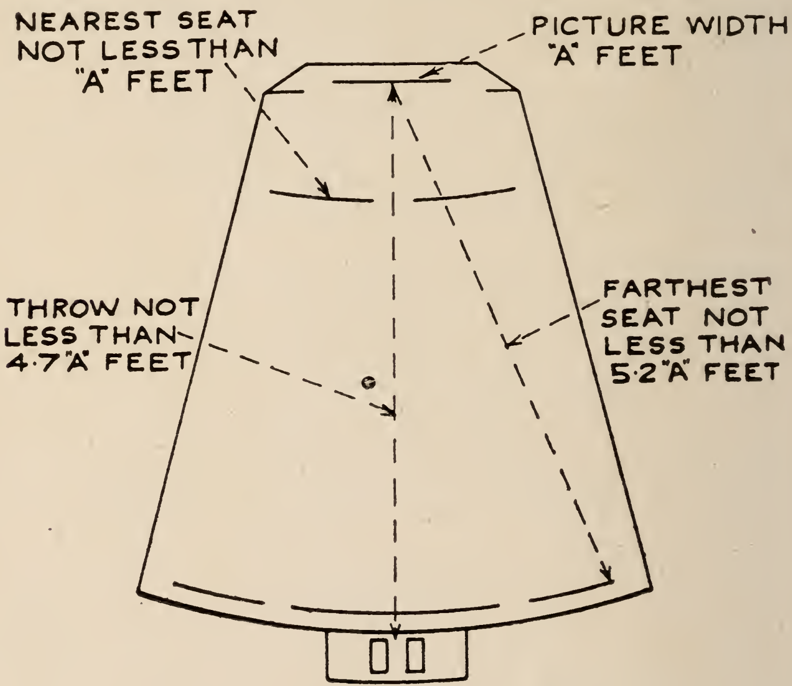

Fig. 2. Optimum Proportions of Auditorium.

intensities, making it suitable for the satisfactory illumination of most sizes of kinema screens met in common practice. The size and type of arc used governs the ultimate luminous output of the projector, which in turn limits the size of the screen which can be adequately illuminated.

The light on the aperture, and ultimately on the screen, depends on two factors :

(*a*) The intrinsic brilliancy of the crater.
(*b*) The physical size of the crater.

The intrinsic brilliancy of the crater depends on the type and composition of the carbon used, and also on the current density, the latter being of great importance if the arc is to give its best results. All carbon electrodes for arc lamps are designed to be burned between specified maximum and minimum amperages. The variation in light output between these ratings, particularly

n the case of high-intensity carbons, is quite pronounced, and when arcs are run below their minimum ratings, the light output has usually become very poor in quality as well as quantity.

In the graph of Fig. 3, showing the variation in total light output of an 8mm. H.I. arc lamp, it can be seen that at the minimum amperage of 56 the total screen light is approximately 75 per cent. of the light obtained at the maximum current of 65 ampères. Because of this fact it is usually necessary to burn arcs at or near their maximum rating to obtain a satisfactory illumination of large screens.

Light Distribution

In the case of H.I. arcs the brilliancy varies across the positive crater and is usually at its highest value near the centre. This variation in brilliancy has some effect on the distribution of light across the screen and in general produces greater illumination at the centre of the picture.

With low-intensity arcs the brilliancy is practically uniform over the crater, producing a flatter screen distribution. However, with all arc lamps the distribution of screen illumination is governed to quite a large extent by the position of the arc with respect to the focus of the optical system of the lamp.

Several factors govern the light output of the projector, the main ones being the angle of collection of the optical system of the arc lamp, and the optical speeds of the projection lens and the arc lamp optical system.

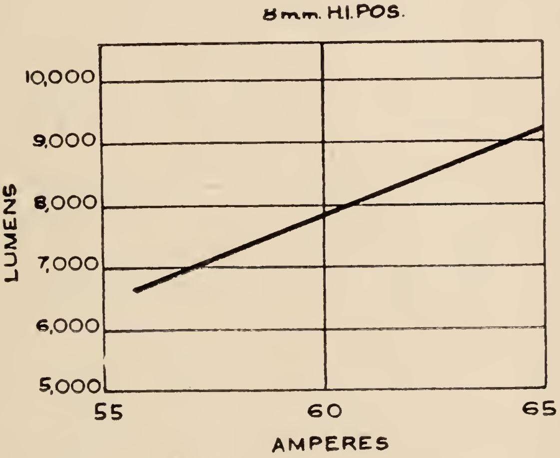

Fig. 3. Light Output of H.I. Arc Lamp using 8 mm. Positive Carbon.

Types of Arcs

The types of carbon arcs in general use fall into the following main categories :

(*a*) Low Intensity.
(*b*) High Intensity at medium amperages.
(*c*) Small H.I. at high current densities.
(*d*) Rotating H.I. arcs not copper coated.
(*e*) Alternating current arcs.

The table indicates the luminous output of some typical arc light sources, showing the brilliancies of the craters with the total luminous output from the arc. The luminous output of the complete projector is much less than the total output from the arc itself. This is due to the fact that the collecting system of the arc lamp does not pick up all the light from the arc, and several additional losses occur.

It should be noted that the figures quoted in the preceding table are those obtained regularly in general practice and are not the maxima which can be reached. Research and development are already producing brilliancies of a higher order, to enable greater light output to be obtained from the carbon arc lamp.

Incident and Reflected Light

Consistent illumination needs only short reference as it is easily obtainable by the use of modern projector arc lamps, using proper carbon combinations under correct electrical conditions. The provision of adequate illumination is, however, quite another matter. Until such time as the B.S.I. committee reaches conclusions, it is suggested that we should adhere to the S.M.P.E. standard of brightness and endeavour to obtain at least the minimum laid down under this.

The latest revision of the S.M.P.E. standard requires that the picture should have a centre brightness of between 9 and 14 foot-lamberts. Screen illumination is more generally detailed in foot-candles, covering a measure of the incident light, and unless the difference is clearly understood confusion arises.

The foot-lambert, equalling one lumen emitted per square foot, makes allowance for the reflection factor of the screen surface. If this be accepted as averaging 70%, then a foot-candle or incident ray reading taken at the centre of the screen should give between 13 minimum and 20 maximum, as compared with the aforementioned figures.

Positive	Negative	Amps	Volts	Lamp	I.B. Candles/mm²		Total Flux Lumens	Crater dia.
					Mean	Max.		
13mm. L.I.	9mm. LI.	35	50	90° Angular	180	190	39,700	8.5mm.
11mm. HI. cc.	8mm. HI.	85	36	90° Angular	260	350	210,000	7.5mm.
8mm. SUPREX	7mm. HI.	65	40	Horizontal	430	690	180,000	7.1mm.
13.6mm. HI.	11mm. HI.	140	68	45° Angular	615	800	650,000	11.5mm.
8mm. A.C.		90	27	Horizontal	340	380	150,000	5.0mm.

Auditorium Proportions

We are now in a position to specify what this standard means to the architect. To obtain the minimum recommended brightness when using equipment giving the maximum light output now possible, the engineer must not be called upon to illuminate a picture size in excess of 24 feet in width. This figure permits the use of previously suggested factors to determine certain desirable maxima and minima :

(*a*) using the factor of 5.2, the distance from the screen of the farthest seat must not be more than 125 feet ;

(*b*) using the factor of 1.0, the distance from the screen of the nearest seat must not be less than 24 feet ; and

(*c*) using the factor of 4.7, the throw must not be less than 110 feet.

In the past, the engineer was generally faced with a completed set of plans as his first introduction to the job. On these plans the seating was already disposed, and if the kinema was to be a large one, the engineer then had the unenviable task of compromising between the correct size of picture to suit

the auditorium characteristics and one suitable to the amount of light available to produce a satisfactory picture brightness.

Screen Size

A survey carried out on a representative group of kinemas in this country and compared with a similar survey made in the U.S.A., revealed that picture areas here are roughly 40 per cent. larger than those in the U.S.A., which inevitably means that they are only about 60 per cent. as bright. It is to be hoped that the days are happily past when exhibitors insisted on larger and larger picture areas, with an utter disregard to the limitations of illuminating them, and then assumed a hurt expression when they found their large pictures to be dull and uninteresting, while their less expansively minded competitors had bright and sparkling picture presentation.

Reference may well be made here to Magnascopic picture presentation. This is acceptable as a medium for the impressive presentation of certain trailers or special short items, but the fact that the average Magnascopic picture has a brightness factor only 50 per cent. of normal speaks for itself.

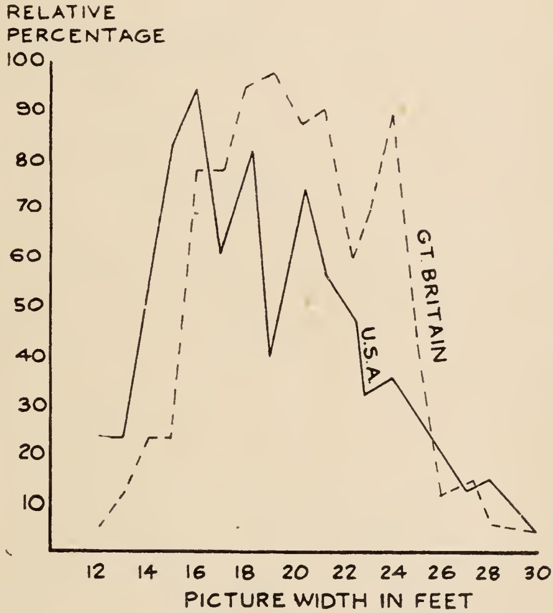

Fig. 4. Relation of Screen Sizes in Great Britain and United States.

Eyestrain Regulations

Before leaving Item 4, it is necessary to refer to the existing eyestrain regulations. In 1920 a Joint Committee of the I.E.S. and others investigated the matter at some length. Their subsequent findings were adopted by the leading Licensing Authorities and are well known to kinema architects. The suggestions contained in the report were designed to provide that persons seated at the extremes of horizontal visual angle should not have to turn their heads more than 65 degrees from normal to take in the farthest vertical boundary of the picture, and similarly, that persons seated at the extremes of vertical vision angle should not have to elevate their heads more than 35 degrees from normal to take in the farthest horizontal boundary of the picture.

To sum up on the question of picture size and screen illumination, if exhibitors demand auditoria of such dimensions and seating capacities as to make necessary the provision of picture areas in excess of 420 square feet, or demand out-of-proportion picture sizes from the showmanship or publicity angles, then such pictures cannot be adequately illuminated at present nor until such time as technical progress results in the provision of equipments giving greater lumen outputs. Fig. 7 illustrates how a reasonable increase in picture width can result in a doubling of picture area.

5. PICTURE SURROUND

The fifth item is one of securing properly arranged surroundings to the picture and takes into consideration both the stage and that part of the auditorium within the audience's visual angle.

Proscenium *versus* Picture

In many kinemas, even of recent design, it is found that an illusion of small—too small—picture size is caused by the disproportionately large, proscenium opening. In this connection it is hoped that architects will design the proscenium, if such be needed at all, round the picture size as required by auditorium dimensions and seating layout, rather than attempt to create an impressive proscenium opening, the very size of which makes it impossible to fill it proportionately without making the picture unnecessarily large, to the ultimate detriment of screen illumination.

Fig. 8 shows how with two exactly similar size pictures, one will appear to be much larger than the other.

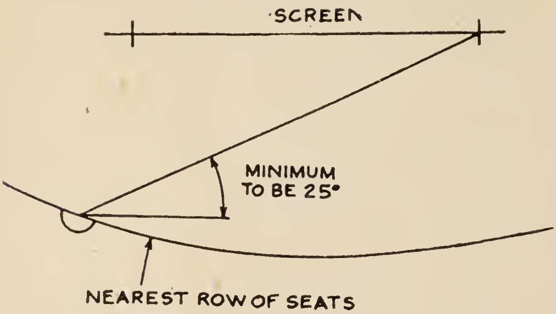

Fig. 5. Minimum Lateral Viewing Angle.

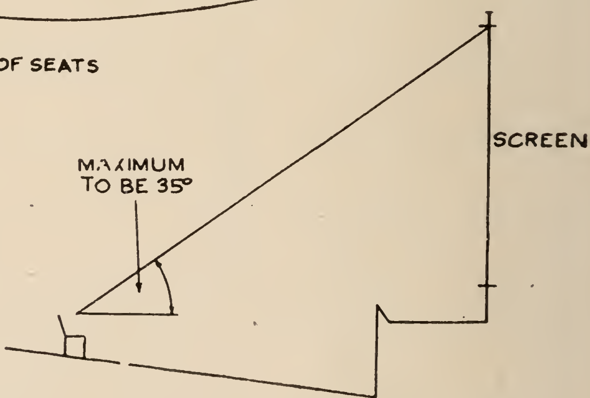

Fig. 6. Maximum Vertical Viewing Angle.

Avoidance of Glare

A most important aim is the avoidance of glare spots which cause distraction, for glare causes discomfort to the eye which in prolonged exposure produces fatigue, and in its most intense forms may cause injury to the eye. It is seldom that glare spots in kinemas are such as to cause disability glare, but cases of discomfort glare are quite frequent.

Excessive glare lowers visual acuity, and when consideration is given to illuminated screen surrounds it should be remembered that a lowering of visual acuity will be experienced if the surroundings are at any time of a brightness greater than that of the picture.

Clocks and Exit Signs

The most usual offender where glare is considered is undoubtedly the clock or clocks which are nearly always placed at the sides of the proscenium arch.

These are generally illuminated to such a degree as to constitute a very serious menace, or conversely are so dimly lit as to make it practically impossible to tell the time. The question of clock positioning has always presented difficulties, and although in several cases they have been located well to the sides of the auditorium, this causes them to be seen by the corner of the eye, which is particularly sensitive to a small lighted object, for this part of the eye is better adapted to night vision than the fovea. The fact that the solid visual angle for one eye is over 90 degrees in the horizontal plane makes it nearly impossible to position the clock outside the normal visual angle unless it be placed behind the audience. This has been done in several cases, but the danger here is that the audience will remain entirely unaware of the clock's existence.

It would seem that the solution lies in linking the clock lighting circuit to the trailer dimmer controlling the screen curtain lighting. This would have the effect of giving a brightly lit clock face only when there is no picture being projected on the screen, and comparatively few of the audience want to know the time in the course of a picture presentation.

Exit Doors

Another, and similar, type of glare spot is to be found in kinemas so designed as to make the provision of exit doors necessary at the sides of the proscenium, for these doors must have well illuminated exit box signs. In quite a few kinemas the maintained lighting fittings have been badly positioned and create glare spots. To instance a particular case, a certain kinema has gangway lighting carried out from fittings placed under the seat standards, and the unfortunately placed patron has a string of red lights in his visual field which closely resemble the warning lights used at night over road construction works.

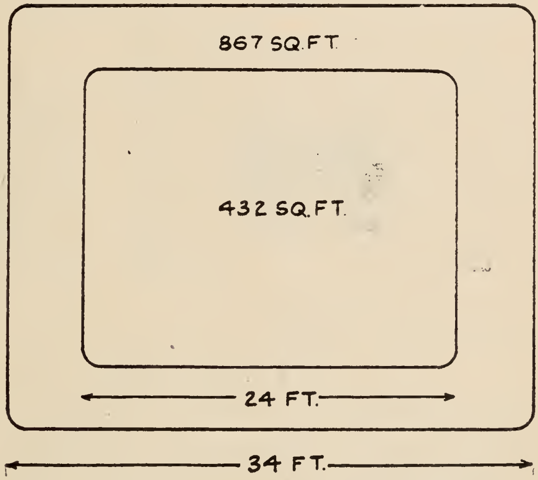

Fig. 7. Relation between Picture Width and Area.

Glare, even in its mildest form, must be avoided. There have even been examples where, due to the simultaneous opening of two doors, a shaft of brilliant sunshine has been projected on to the screen during picture presentation or has caused an intermittent glare spot to appear on the walls near the proscenium.

Re-reflection of Picture

Re-reflection of the picture is another great source of unconscious annoyance to patrons. The offending surface need not necessarily be specular in nature, such as the glass panels in a badly positioned lighting fitting, but can be light decorative features, stage floors, orchestra well coverings, organs, etc., which will all re-reflect the picture under certain conditions. Such a distraction is doubly irritating owing to the image movement which is constantly taking place, making itself felt even if the re-reflection be weak or nearly out of the visual angle.

Avoidance of Stray Light

Light sources at the proscenium surround should not be directly visible if at all possible, for indirect illumination is much to be preferred. Some architects and engineers seem to be under the erroneous impression that as long as light sources are directly shielded from the audience, stray light can be allowed to reach the screen without any detrimental effect to picture presentation, and through this belief many presentations have been spoilt as far as picture contrast is concerned. If a kinema is lit as it is normally when picture presentation is in progress and observation is made from the centre of the screen, it will often be found that several relatively bright light sources are directly visible. Steps should be taken to ensure that directional baffles are provided to mask any such stray light from falling upon the screen.

6. THE SCREEN

Having obtained a certain quantity of light, covering a certain area at the position of the screen, the proper distribution of this light through reflection and refraction has to be considered. There are several types of screen material available, all having different distribution curves and reflection factors, which can be suited to certain shaped auditoria, and a very brief summary of these would not be out of place.

The glass-beaded screen, by refracting the reflected ray, can increase the

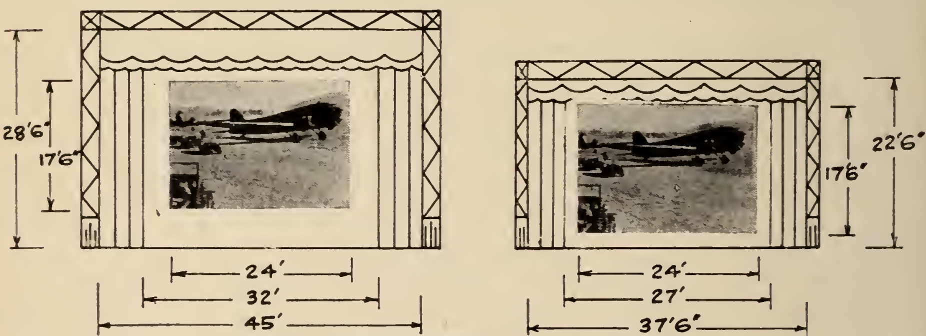

Fig. 8. Effect of Proscenium in dwarfing Picture.

apparent brightness by several hundred per cent. Unfortunately, this greatly increased brightness is only available over an arc of about 25 degrees, with a very high central node. Outside this arc, the apparent brightness of the picture falls off considerably. One further aggravation is that the glass screen is a high refractor. In other words, it throws the picture back into the projection room and starves the patrons in the stalls.

The silver screen has approximately the same angle of response as a glass-beaded screen, but in this case acts as a true reflector and throws the picture, with great brilliance, into the front of the stalls, and, governed by the projection rake, starves the patrons in the circle.

Under conditions found in a modern kinema, where at least 90 degrees horizontal arc of response from the screen is required, it becomes clear why the matt white diffusing screen, which spreads the picture it receives everywhere, is, up to now, the one mainly used.

Improving Screen Efficiency

The disadvantage of the flat white screen is that it throws the picture out over a complete hemisphere. Since the audience is disposed within an arc of about 90 degrees in the horizontal axis and about 30 degrees in the vertical

axis, it is clear that this type of screen is throwing most of its picture into areas where it is of no use. The actual ratio of the area of an ellipse, enclosing the audience as aforementioned, and a hemisphere is 5 : 1. In other words, the screen is yielding to the paying audience a picture only 20 per cent. as bright as its total yield.

There have been attempts, usually by lenticulated screens, to overcome this great waste. The only successful ones have cost a great deal of money, but the ordinary kinema has not such an acute need as would justify so large an outlay. Much experimental work has gone on to produce a screen having all the desirable characteristics, but which is, at the same time, within reasonable distance of the cost of the existing type of screen. There are signs of some degree of success in this direction.

The perforation of a screen sometimes comes in for criticism. However, anything up to a width or diameter of 1/16 in. is unlikely to be seen, as the resolving power of the eye may be taken as one part in 3,438. This makes the limiting distance at which such perforation is visible as 18 ft.

Screen Discoloration

An ever present problem of kinema owners is discoloration of the screen.

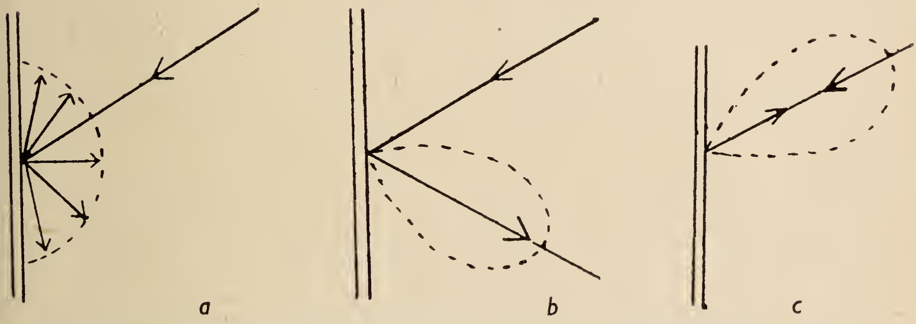

Fig. 9. Reflectivity Characteristics of Screen Surfaces :] (a) Matte, (b) Silver, (c) Beaded.

This is caused partially by the surface dust, but very much in the main by tar contamination through smoking[3].

The authors venture the view that this contamination is approximately a function of the number of admissions at the box office, multiplied by the cleanliness ratio of the kinema.

The modern plenum system can keep the latter down to a low figure, but where it is deficient or the extract is taken, in the main, from over the stage, the cleanliness ratio can become very high indeed. It is also an unfortunate fact that there are still kinemas being built with radiators and hot water pipes immediately below the screen, and this can have dire results.

This prevalence of extracts over the stage is probably the result of some architectural textbooks advocating such a scheme, perhaps because it is highly convenient from a structural and design point of view. If some architects were to take a trip up into the flies of a kinema which has been open several years and has been extracting over the stage, and they made contact with the borders and legs and other stage drapes, then they would descend in such a state as could only be compared with the proverbial sweep. If a portion of the extract must be taken over the stage (if a stage is being used) as required by the Authorities, surely it could be drawn off without making the stage drapes and screen filthy[4].

Frequently, there are complaints of dark patches appearing on the screen. Almost without exception, these are caused by draughts passing through the screen. Architects should pay particular attention to the prevention of draughts in horn chamber doors and to the acoustic blanket at the back of the screen.

Illuminated Screen Surround

As to possible trends in the future the authors would hesitate to make prophecies, but as one controversial offering, they would suggest the so-called "illuminated surround." In their view, this is most unfortunately named, tending to suggest contrast as does a hard black line, whereas a real aim of the scheme is a diffused falling off of the picture into the auditorium.

There is no doubt that experimental kinemas of this type will be built, and may be a success. What might be considered here is whether in such circumstances the existing 5,000 kinemas can be converted to such a scheme of projection if the need arose. It is thought that a fairly inexpensive scheme of contoured surfaces merging the screen with the auditorium could be produced which would still enable the stage to be used as a stage if necessary. The essential effect of these is, of course, the suppression of the proscenium arch.

Most of the work on the optical side of schemes such as this has been done by using additional light of various hues made to blend with the edge of the picture. The authors feel that this bears the criticism of introducing more equipment to buy and maintain. It would be an advantage if the extra light could be obtained from the existing projector through a modification of frame size.

It is suggested that a better description of this type of scheme is "wide vision" or "full vision" picture.

Value of Presentation

In conclusion, those whose business takes them into many kinemas up and down the country know exactly what a vast gulf separates the kinema where motion picture presentation is clear and sparkling from its counterpart where presentation is marred by obstructions, glare spots, and a dull picture. The kinema public may not be aware of the causes lying behind presentation of the latter kind nor of the considerable work and careful planning that results in presentation of the former kind, and have to suffer or go elsewhere—a step they are increasingly taking.

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DISCUSSION.

Mr. A. G. D. West : It has been stated that it is possible to increase the apparent contrast of the picture by a slight illumination around the screen. Is there any truth in this ?

Mr. J. L. Stableford : It is bound up with the physiology of viewing. The main effect of the picture is taken in through foveal vision, and you are taking in the remainder of the picture through macular vision. If this is subject to a sharp contrast, one is not able to get as sensitive an impression of the picture.

Mr. R. H. Cricks : A point which should be borne in mind, both in connection with the proposed screen surround lit by stray light, and in regard to reflection from the side walls of the auditorium, is that the eye becomes very sensitive to flicker at the sides of the retina.

Mr. I. D. Wratten : The increase in angle is so slight that the flicker aspect does not come into it at all. I have seen similar surrounds in America ; the idea is that the surround is controlled by some means so that a change in the hue of the surround is controlled by a change in the picture.

Mr. Rexham : Is it correct that if smoking were discontinued in kinemas, the average illumination would be raised by 40% or 50% ?

Mr. R. Pulman : I think it might be reasonably correct. It depends entirely on the heating and ventilating system of the kinema.

Mr. I. D. Wratten : In the United States, the quality of the picture on the screen is superior to that in Great Britain. There seems to be little question that the " No smoking " rule has something to do with it. Another thing is the question of screen size. Apparently for some years in this country there has been a desire to get bigger screens with the same amount of illumination, and the result has been to make for poor picture presentation, and in the end actually to affect the print itself. The average print made in this country has a slightly lower overall density than a comparative print in the States.

Mr. R. H. Cricks : Little notice seems to be taken of the very considerable picture distortion due to viewing off-centre. Is that problem insuperable ?

Mr. J. L. Stableford : There is no doubt that a commercial kinema can be built where viewing distortion is negligible. The only point is that the kinema is probably going to have a picture size of 18 ft., and is going to seat 1,000 people. You come up against the trouble that a 1,000-seater kinema is not a paying proposition.

Mr. E. Oram : Manufacturers of equipment must pay more attention to their lens fitting. The requirements are that the lens shall be close to the film gate, and on British equipment you cannot increase the size of the lens near the film gate. In a large theatre with a long throw you get a smaller aperture lens just when you want a larger aperture.

A Visitor : I was interested in your factor of 4.7, the ratio between the screen width and the minimum throw. What is the reason for that figure ?

Mr. R. Pulman : You will find that that factor of 4.7 will give a lens focus which is somewhere about 4 ins. focal length. If the lens focus is about 2 ins. or 2½ ins., it is very difficult to get anything approaching the flatness of field that we require in the corners of the screen.

Mr. A. H. C. Rouse : Have any experiments been made with luminescent screens, making use of the light invisible to the eye ?

Mr. H. P. Woods : If you examine the spectrum curve of an arc lamp you would find that the ultra-violet energy would not be more than 10%.

Mr. H. J. O'Dell : From what has been said, it is obvious that we need a simple portable instrument for measuring screen illumination. There are many good types of foot-candle meters available, but the authors recommended that we should check the foot-lamberts. I would be glad to have

their views on the availability of suitable instruments.

Mr. J. L. STABLEFORD: There are several instruments we can use; but they give arbitrary readings. Any photometer reading should be based on the curve of the human eye. The only way one can approach this problem is to get a comparator type of instrument, in which a given standard of brightness is applied with a given standard of spectral response, and your screen should be measured at regular intervals against this comparator.

II.—ACOUSTICS

L. Audigier (*Member*),* A. P. Castellain, A.C.G.I., D.I.C. (*Member*),† W. F. Garling (*Member*),‡ and L. Knopp, Ph.D., M.Sc., M.I.Mar.E. (*Fellow*).§

Read by Mr. Knopp to the British Kinematograph Society on September 11th, 1946, and by Mr. J. Dobson (Member) to the Newcastle-on-Tyne section of the Theatre Division on February 4, 1947.

WITHIN recent years architectural acoustics has become a subject of increasing importance, and in submitting the following fundamental requirements for acoustical conditions in kinema auditoria the authors have not been unmindful of other requirements which are of major importance, such as, for instance, the satisfactory projection of the picture, but none of the recommendations will be found to be incompatible with or prejudicial to these other considerations.

The authors have also borne in mind future developments in sound motion picture engineering. The installation of more modern reproducer equipment, or the introduction of stereophonic sound, will not of itself materially alter these fundamental requirements, but rather make their satisfaction more imperative.

1. ACOUSTIC REQUIREMENTS

A kinema may be said to possess good listening conditions when :—

1. The components of complex sound maintain their proper relationship ;
2. Successive sounds in fast-moving speech or music are clear and distinct ;
3. The sound loudness is adequate in all parts of the auditorium ;
4. There is an "intimacy" or "presence" between the focal interest of the projected picture and the source of sound ;
5. There is freedom from extraneous noise.

These conditions cannot be realised in auditoria where the following acoustic defects are present :—

(*a*) Unsatisfactory reflection effects, which will alter the amplitude of fundamentals and absorb or distort the partials of complex sound, resulting in low intelligibility of speech, poor quality of music, and sometimes will produce objectionable echoes.

(*b*) Unsatisfactory reverberation time, which, if too short, will produce "life-less sound" and if too long, will reduce intelligibility.

(*c*) Uneven distribution of sound throughout the seating area, producing concentration in some places and paucity in others.

(*d*) Excessive auditorium noise level, arising either internally or externally, and destroying good sound reception by interference.

In addition to the foregoing, poor acoustic transmission characteristics can arise from defects in the picture screen.

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‡ RCA Photophone Ltd.

Reverberation Time

The reverberation time of an enclosed space is the interval of time between the stopping of a source of sound and the moment when the subsequent reverberation dies away to inaudibility, or, more specifically, the time taken for the sound to decay 60 decibels. Reverberation time is ordinarily a function of the size of the enclosed space and the quantity and nature of the absorbent material within it. The total length of the path of a sound-wave within the enclosed space is co-related to the internal dimensions, and the absorption qualities of the wall surfaces become a factor, because upon them depends the amount of energy extracted from the sound waves as they strike the various surfaces.

In music the slow decay of sound is not a serious objection, and in some cases may even be desired, especially when succeeding sounds are harmonious : it improves the sonority and impressiveness of slow stately music, but it introduces a blurring effect to rapidly moving staccato passages. In speech a limited amount of reverberation has a beneficial effect, but when excessive it causes confusion and low intelligibility.

Reverberation time below optimum is undesirable. It imparts an unnatural quality to the sound and involves the radiation of an excessive quantity of sound energy from the speaker units.

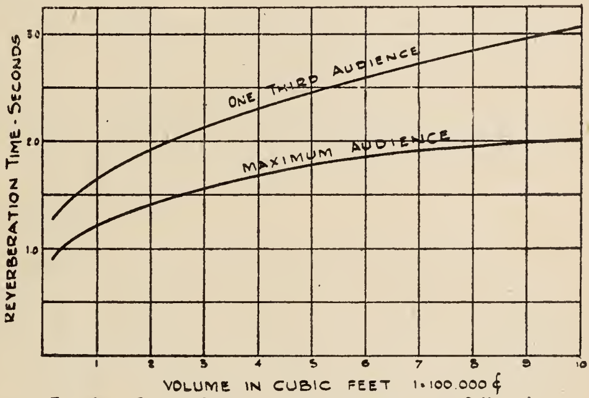


Fig. 1. *Curve of Maximum Reverberation at full and at one-third Audience.*

Because of the importance of reverberation time, Knudsen instituted a method of quantitative measurement by articulation tests which afforded a ready means of ascertaining the intelligibility of speech under various conditions. The general results of his investigations showed that if the reverberation time of a particular auditorium was 4.8 seconds, the syllabic articulation is 65 per cent., and the hearing conditions were unsatisfactory ; at 3 seconds reverberation period the syllabic articulation improved to 75 per cent., but such conditions were barely satisfactory even to an attentive listener ; with 1.8 seconds reverberation time or less, the syllabic articulation increased to 85 per cent. or more, at which sound conditions for speech might be considered satisfactory.

Sabine, Watson and Lifshitz's independent investigations show that the maximum reverberation times (*a*) with 1/3rd audience and (*b*) with the maximum audience should not exceed those shown in Fig. 1, where the reverberation times are based upon the cubic capacity of the auditoria.

Frequency Response

Investigation shows that it is not desirable to provide a uniform reverberation time throughout the full frequency range ; in auditoria in which the acoustic conditions are considered good, the reverberation time is invariably greater at the lower frequencies. The recommendations of the Research Council of the Academy of Motion Picture Arts and Sciences for the optimum reverberation period at frequencies from 50 to 1,000 cycles are given in Fig. 2.

Mason and Moir have published curves of optimum reverberation time at a mean frequency of 500 cycles per second, shown in Fig. 3. This curve has been amplified by another, shown in Fig. 4, which indicates the variation of

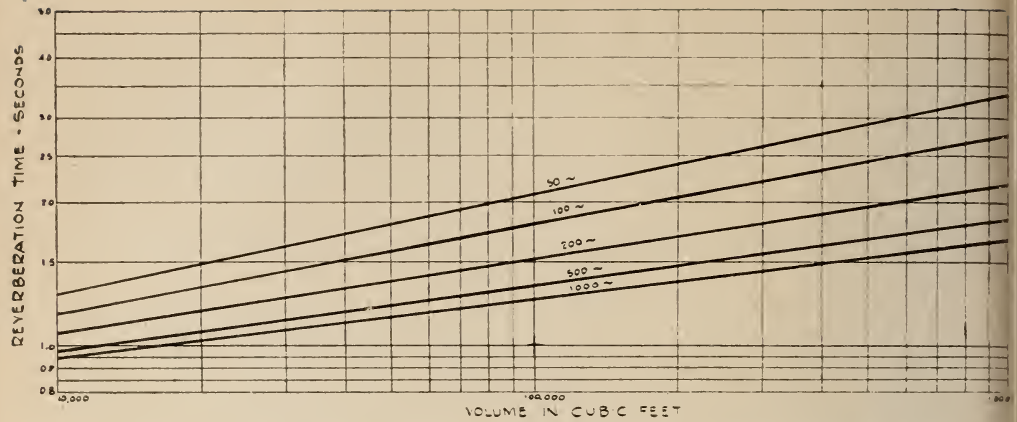


Fig. 2. *Optimum Reverberation Time at various frequencies. (Academy of Motion Picture Arts and Sciences.)*

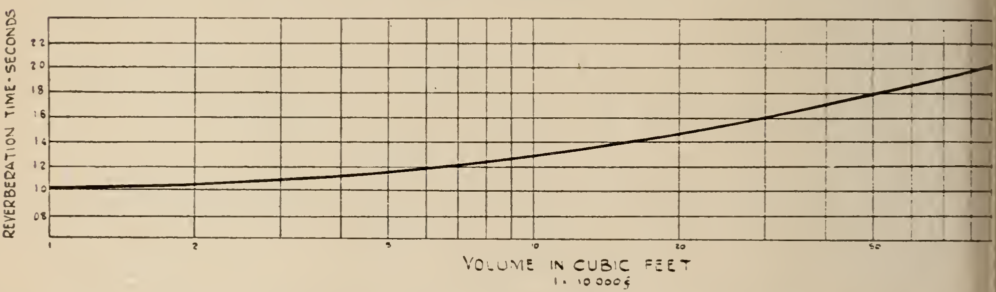


Fig. 3. *Optimum Reverberation Time at 500 cycles. (Mason & Moir.)*

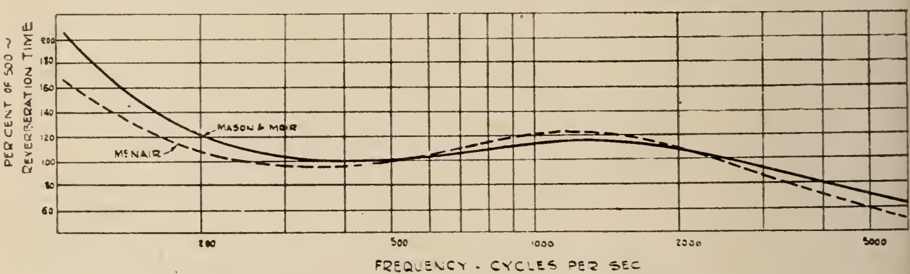


Fig. 4. *Variation of Reverberation Time for various Frequencies.*

reverberation time at frequencies between 100 and 5,000 cycles per second. The variation is expressed as a percentage of the reverberation period at the basic frequency of 500 cycles. A comparison with the earlier research of McNair is also shown.

It is the opinion of the authors that reverberation times closely approximating those shown in Figs. 2–4 should satisfactorily meet one of the primary conditions for good listening.

Intimacy of Speech

The optimum reverberation times for speech and music are not the same, but as the intelligibility of the former is generally regarded as being the more important, the reverberation times recommended favour the speech requirements.

"Intimacy" or "presence" will benefit from this recommendation. Good "intimacy" should give the impression to all members of the audience that the sound is emanating from the characters on the screen. This is primarily achieved by the reception of direct rather than reflected sound.

Closely associated with the reverberation-volume relationship is the ratio between volume and seating capacity. For good acoustic conditions the volume of the auditorium per seat of audience should lie between the maximum and minimum curves given in Fig. 6. If a greater volume per seat than that recommended by the curve be adopted, excessive reverberation is likely to occur; and if a lesser volume, the sound will have an unnatural quality.

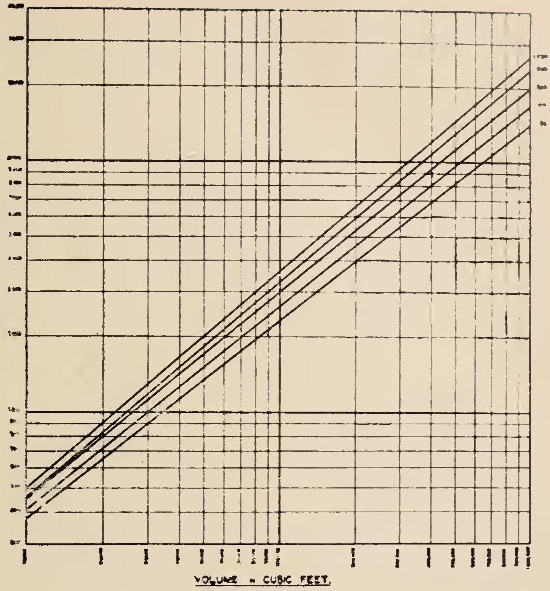


Fig. 5. *Absorption at various Frequencies.*

Reflection Effects

When a sound wave strikes a wall or other object its energy is dissipated in three ways: it is partially reflected, transmitted and absorbed. In the case of surfaces large in comparison with the wave-length of the sound, the reflection is analogous to the reflection of light; and the angle of incidence of the sound is equal to the angle of reflection. The relative amounts of acoustic energy reflected and absorbed by a material vary not only with the angle of incidence and with the frequency of the sound, but also with the nature and quantity of the material itself. Whilst it is possible only to double the sound energy at any one point due to a single reflection, the decreased level or cancellation effect can be infinite, and thus any absorption at a point of reflection will tend to decrease both the additive and subtractive components of sound, and thus minimize any modifications of the characteristics of the direct sound.

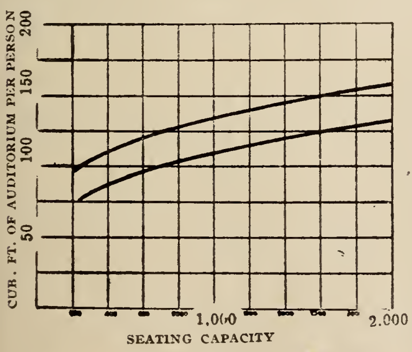


Fig. 6. *Ratios of cubic feet volume per seat (maxima and minima.)*

The choice of the building materials of the walls and ceilings and the natureof the furnishings have a large influence upon the acoustic conditions in the auditorium. The absorption coefficients of building materials vary greatly, and as will be seen in Fig. 7, each material has widely different absorption coefficients at different frequencies. Judicious choice of materials used is therefore necessary if the components of complex sound are to maintain their proper relationship. The materials selected should possess a smooth absorption characteristic, and particularly with adequate absorptivity throughout the

ower frequencies. Materials recently developed are of such varied design and construction that it is possible to obtain the proper sound absorption characteristics in almost any type of auditorium, and thereby obtain the desired acoustic effects.

Sound Waves in the Auditorium

The unsatisfactory shape or size of an auditorium, and the focusing effect of wrongly shaped reflecting surfaces, produce echoes and objectionable concentrations of sound which are the basis of many of the major acoustic defects in present day auditoria.

In Fig. 8 are shown the successive stages of the progress of a sound wave in a sectional model of a badly shaped auditorium. It will be seen in (1) that the initial sound wave is closely followed by another of almost equal intensity due to the reflection from the horn-chamber. In the subsequent views are

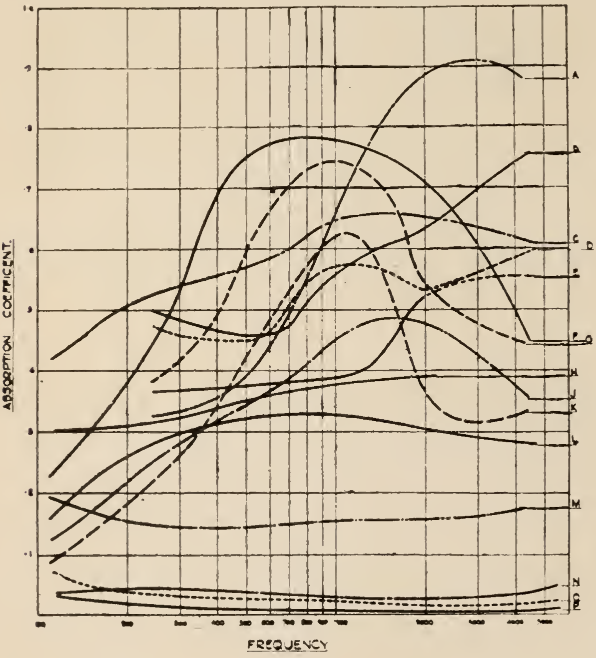


Fig 7.

Absorption Characteristics of Various Materials.

A. Thatchboard covered with paper, hangers and canvas. (*McNair.*)
B. 2 in. of bare Thatchboard (*Bureau of Standards.*)
C. Acoustic Rock Wool 4 in. thick behind wire net and muslin. (*Knudsen.*)
D. Thatchboard covered with perforated metal. (*Building Research Station.*)
E. Eelgrass Quilt 3-ply scrim covered (*Sabine.*)
F. Eelgrass Quilt 3-ply 2 layers 1½ in. from wall and Canvas Cover 1 in. distant.
G. AcousticCelotex BB type.(*Sabine.*)
H. ½ in. double Insulite with f in Air space. (*Building Research Station.*)
J. 1 in. Nashkote asbestos felt fabric painted AX finish. (*McNair.*)
K. 1 in. Hair felt 1½ in. from wall *McNair.*)
L. ½ in. Masonite fibre board on 2 in. x 1 in. studs at 12 in. c/c. (*Sabine.*)
M. 7/16 in. Celotex standard board on 4 in. x 2 in. studs. (*Sabine.*)
N. ¼ in. Lino. (*Building Research Station.*)
O. 2 in. Wood (Pine). (*Behm.*)
P. Marble. (*Behm.*)

shown the almost complete absence of direct sound in the rear stalls due to the bad design of the balcony front and the excessive balcony rake ; and the sound reflections from the roof dome and the rear wall of the balcony concentrating in the balcony area.

To obviate long path echoes in an auditorium the nature of the wall and ceiling surfaces should be such as to absorb the sound falling upon them, or preferably, the shape and position of the surfaces relative to the source of the sound should be such as thoroughly to diffuse the reflected sound.

A very high proportion of the sound reaching the ears of the audience should come by direct path, or by paths differing at most by 45 feet from the direct path, *i.e.*, the maximum time interval between the reception of the direct and indirect sound wave is 1/25th seconds. It is possible that this permissible difference of sound path length will have to be rigidly enforced, and possibly reduced, for such future sound developments as stereophonic sound, where the apparent sound source has to move across and even off the screen.

Auditorium Noise Level

The exclusion of noise arising from without and the reduction of extraneous noise arising within the auditorium are important factors. Not infrequently kinemas are situated in busy main streets and street noise is a cause of complaint. Investigation has shown that the equivalent loudness of outdoor noise can vary between 70 phons in a local shopping road to 100 phons in a main road carrying heavy motorised traffic. These values represent the loudness at the kerb-side, and, although there is a progressive diminution in intensity as the distance from the sound source increases, reflection of noises from one side of a street to the other enhances the general loudness and promotes its continuity. This increase in loudness may under some circumstances reach 5 phons.

Noise from street sources can be introduced into the auditorium through

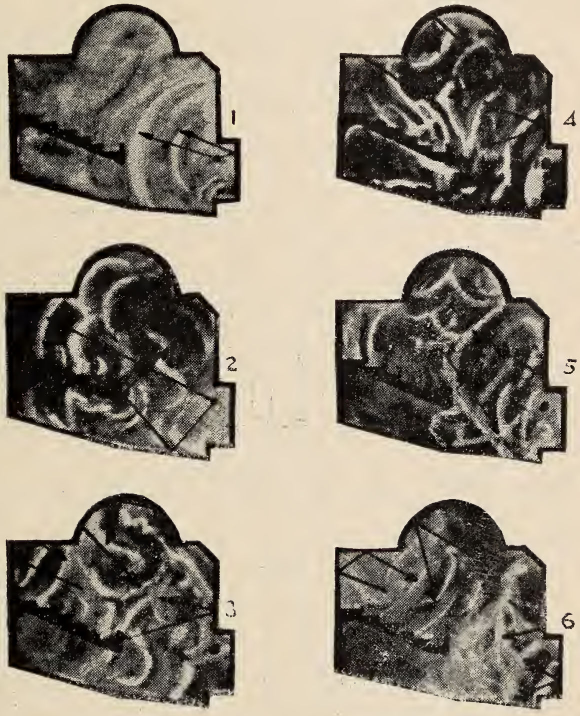


Fig. 8.
Successive Reflections of Sound Wave in badly shaped Auditorium.

three different channels, *viz.*, by direct path through cracks around doors, by flexural movement of walls and floors which vibrate as diaphragms and readily transmit low and medium frequencies, and by vibrations set up within the whole structure which transmit the higher frequencies.

The reduction of street noise by direct path is most satisfactorily attained by insulating the auditorium by means of entrance lobbies with close fitting doors, and by avoiding any exits which open directly from the auditorium on to the street.

The quantity of noise transmitted by flexural movement and vibrations is largely a function of the kind of material employed in the structure ; and the mass or weight is a reasonable guide to the insulation properties of the material. Fig. 9 indicates this relationship between weight of structure and sound reduction, and generally speaking, the relationship is such that each time the weight per unit area of the material is doubled the insulation value increases

by the same amount. Consequently the reduction of street noise within an auditorium is dependent upon the solidity of the structure.

A double ceiling may be considered essential, and in cases where the outside noise is likely to be serious a double wall structure should be considered.

Objectionable extraneous noise is frequently introduced into auditoria from the use of worn or badly balanced machinery within the kinema, or the employment of electrical equipment which has not been designed specifically for quiet operation. In addition to the direct noise arising from machinery, attention should also be directed to the reduction of vibration. Again, selection and design is of importance, but, in addition, the proper installation of the equipment and the provision of some form of isolator or absorber are necessary if the transmission of noise is to be prevented. The proper maintenance and the early replacement of worn parts of machinery are essential.

Noises from Projection Room

Machinery and mechanical equipment most closely situated to the auditorium is that in the projection room, and very frequently the audience sitting in close proximity can hear not only the objectionable " whirr " of the projector mechanisms but also the careless handling of spool boxes, change-over

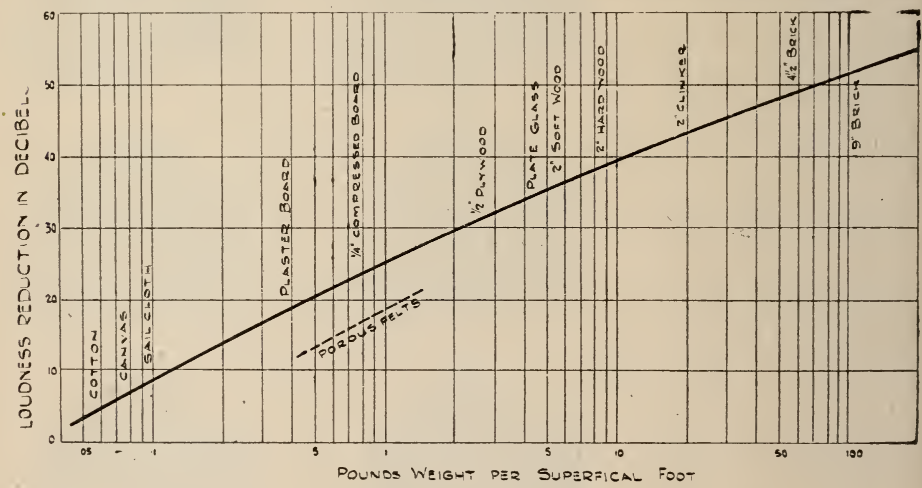


Fig. 9 *Reduction of Sound Loudness in relation to Weight of Structure.*

devices and the like. The design and construction of the projection room should be such that neither air-borne nor structure-borne noise will be transmitted into the auditorium. It is also recommended that the ceilings and walls of the projection room be covered with fireproof acoustic material to reduce the noise level in the projection room to a value not exceeding 40 phons.

Noise Originating in Auditorium

It is, of course, desirable that there shall be no intruding noise entering the auditorium, but it would be a matter of considerable difficulty to render all such noise completely inaudible. It is therefore recommended as a minimum requirement that all such extraneous noise shall be reduced to a level at which it will not normally be a source of annoyance. This level should not exceed a loudness of 35 phons in any part of the auditorium.

The audience itself can be the source of objectionable noise, arising from the movement of seats and the traffic along gangways. The latter should be covered with thick felt and carpet, and where this is not possible, the use of

quiet, resilient floor covering material is recommended. This should not be restricted to the gangways, but should also be used on the floor in the seating area.

Where tip-up seats are used, it is necessary that the stops be well rubbered, and that the chair be so designed as to be as quiet as possible when the seat is being either raised or lowered.

Another common source of noise originating within the auditorium is the use of ill-designed lighting fittings which resonate or rattle.

The Screen

The kinema screen performs two functions : firstly to be opaque to and a good reflector of light, and secondly to transmit sound from the speakers, for which purpose the screen is perforated. The transmission of sound, particularly that of the higher frequency range, is considerably affected by the presence of the screen and the area of its perforations, which comprise only 8 per cent. of the total area when the screen is new.

When a screen is resurfaced the thickness of the screen is invariably increased and the area of the perforations reduced, with a consequential adverse effect upon the sound transmitted, which cannot be corrected by the frequency response characteristics of the reproducer equipment. It is therefore recommended that resurfacing treatment should not be resorted to more than twice, after which the screen should be renewed. Indeed, where a high standard is required the screen should be replaced after its first resurfacing.

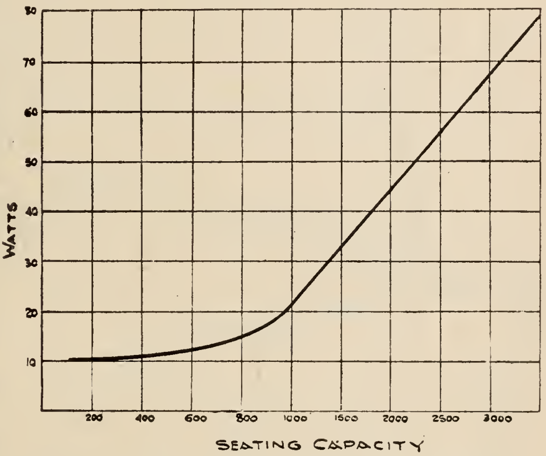


Fig. 10. *Watts output in relation to Seating Capacity.*

2. POWER REQUIREMENTS

The acoustical energy necessary for satisfactory sound reproduction varies with the volume of the auditorium. This energy can be determined only empirically, and its value is most conveniently expressed in terms of electrical watts of amplifier output.

The curve shown in Fig. 10 is the mean of several that have been prepared by various authorities, and it is the opinion of the authors that adherence to this curve will provide adequate volume of sound reproduction for speech, music or for special sound effects. The curve is based upon the assumption that a modern two-way speaker system is installed.

3. OPTIMUM ACOUSTICAL DESIGN

For the purpose of the following proposals it is assumed that the reproducer equipment to be installed is free from intermodulation, that it has a satisfactory frequency response, that it possesses the ability to reproduce transients, and that it is capable of providing adequate sound volume throughout the whole of the seating area. A consideration in connection with the reproducer design, however, which has a fundamental bearing upon the design of the ideal auditorium is the maximum angle of satisfactory distribution for which the modern speaker system can be designed. In the paper presented to this

Society earlier in the year* a maximum subtended angle of 30° from the centre of the screen to the extreme outside front stall seats is mentioned, and consequently it is assumed that the reproducer is designed for this distribution angle.

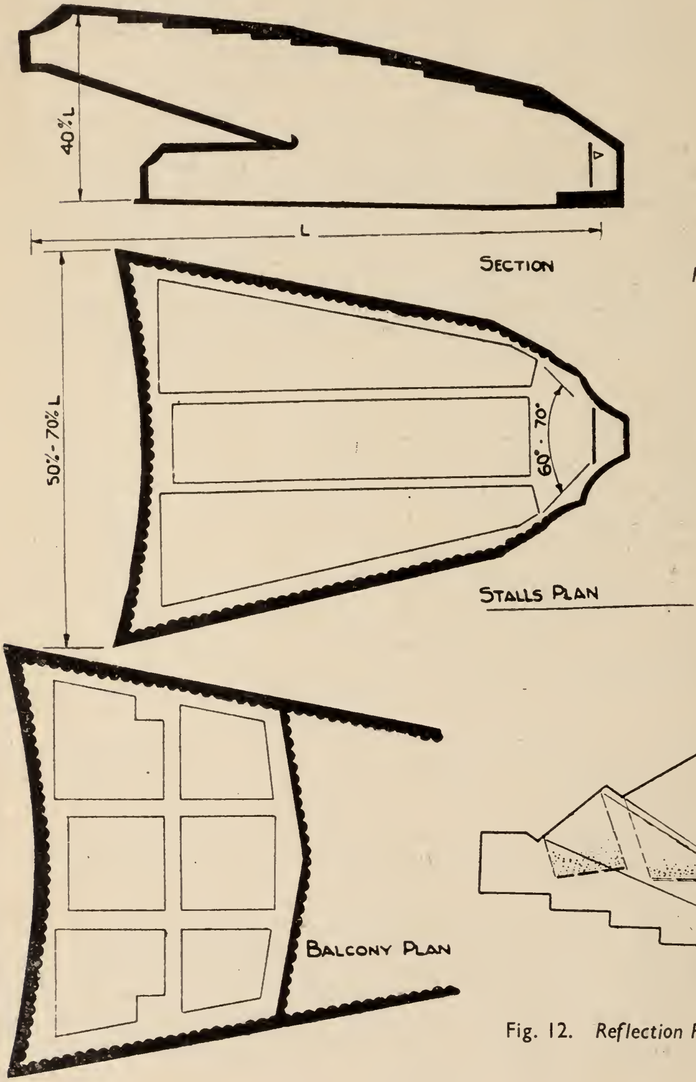


Fig. 11.
Recommended design of Auditorium.

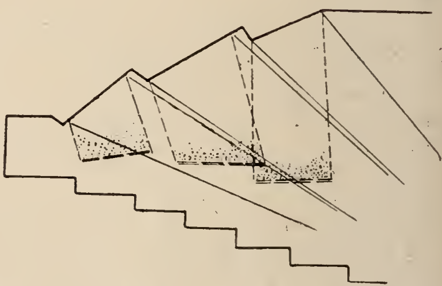


Fig. 12. *Reflection Panels for Rear Seats.*

Proportions of Auditorium

In determining the general dimensions of the auditorium having regard to the shape and area of the site available, an endeavour should be made to restrict the width of the auditorium to between 50 and 70 per cent. of its length. Site conditions do not ordinarily affect ceiling heights, and the authors recommend that this height should not exceed 40 per cent. of the length of the auditorium when a balcony is required, and should not exceed 30 per cent. of the length in a kinema having a single floor.

* Auditorium Requirements in Sound Film Presentation, Part I, by R. E. Pulman, J. L. Stableford, and H. P. Woods, March, 1946.

The suggested general design based upon acoustic principles is shown in Fig. 11. It has accommodation for 1,200 to 1,500 persons, which is the average size of kinema likely to be built in the future.

The width of the auditorium at the screen is $22\frac{1}{2}$ per cent. of the length, increasing to 37 per cent. at the front stalls, with a maximum width at the rear balcony of 70 per cent. of the length. This shape of floor plan provides non-parallel wall surfaces which avoid objectionable cross-reflections of sound, and provides a basic shape which readily accommodates a side wall design which can further assist the proper diffusion of sound. In cases where it is not practicable to use convex side wall surfaces as shown in the illustration, other means should be adopted. These may consist of non-parallel and sloping rectilinear sections which will thoroughly diffuse the sound. These sections should be so positioned in respect of the sound source as to reflect the sound into the sides rather than into the seating area.

No Proscenium

The screen opening is splayed into the side walls to maintain a sound energy flow parallel to them, and it is important that these splays do not reinforce the sound source. Consequently their surfaces should be well broken up. Pillars, panels, decorative lighting arrangements or other reliefs can be used to achieve this if desired, but it is not recommended that such arrangements take the form of a proscenium, which is a legacy of the legitimate theatre, and serves no useful purpose in a kinema unless stage shows are also given. Where this is necessary, however, care should be exercised to ensure that the proscenium does not interrupt the flow of sound energy from the speaker system into the auditorium.

A large portion of the rear of the auditorium is occupied by the balcony. It will be seen from Fig. 11 that the distance from the screen to the rear of the balcony is greater than to the rear stalls, and the balcony overhang has been kept to a minimum to ensure an adequacy of sound in the rear stalls.

Rear Walls

Some authorities recommend the upper portion of the rear walls being set at an angle, as shown in Fig. 12, to form directional reflectors: where these are fitted, the surfaces should be highly finished and non-absorbent so that they function with the highest efficiency, particularly throughout the upper frequency range. On the other hand, however, cases have been reported of objectionable concentration of sound in the rear seating area, and the destruction of " intimacy " or " presence ", due to the sound appearing to come from behind and above the listener instead of from the screen. It is the opinion of the authors that such reflecting panels should be avoided. If the level of the underside of the balcony is kept at a sufficient height so as not to obstruct the direct path of the sound, there should be satisfactory listening conditions in the rear stalls seats, and the rear wall treatment can therefore be arranged to diffuse rather than to concentrate the sound into a given area.

The shape and treatment of the rear walls of both the stalls and balcony are important features in auditorium design. Unbroken wall surfaces cause undesirable reflections into certain portions of the seating area. These reflections can be sufficiently delayed in time and can attain sufficient magnitude to be clearly audible as echoes. Concave rear wall construction, which is a very common feature of present day kinemas, due no doubt to the fact that it follows the natural arc of the seating, is particularly objectionable. It has a focusing effect of the reflected sound, adversely affects sound quality, and not infrequently is the source of echoes.

Whatever form the rear walls may take, it should be such that it uniformly diffuses the sound falling upon it. Convex surfaces provide the highest degree of sound dispersion : such shapes are likely to cause a slight wastage of floor area towards the sides, but it is possible to provide modified convex types of rear walls that will conserve seating area and at the same time eliminate the focal objections inherent in the concave design. The ceiling should be stepped down towards the screen somewhat on the lines indicated. This shape of ceiling has several advantages, but where decorative ceiling lighting is desired, it may be convenient to reverse the serrations or to arrange the steps of the ceiling in a convex fashion. No objection would be raised to such alternative arrangements providing care be exercised to ensure that sound is not reflected back on to the screen.

Ceiling and Balcony

Under no circumstances should domes or concave types of ceiling construction or decoration be used. These invariably focus sound into certain portions of the seating area. The ceiling should not be parallel with the floor, either in the longitudinal or transverse direction.

The front of the balcony should be as narrow as possible and sloped forward in a vee-shape, or well rounded ; in both cases it is advisable to break up the surface with vertical corrugations.

Any remaining surfaces facing the screen such as the vertical partitions behind the rear gangway, and the front of the projection room near the port holes, should similarly be broken up.

In order to reduce the angle of coverage required by the speaker system and thus reduce the total quantity of sound energy reflected into the seating area, it is recommended that the gangways at both the stalls and balcony levels be placed against the side walls.

Horn Chamber

Thought should be given to the means to be adopted for absorbing the sound radiated from the back of the loud speaker system, and sound that may be reflected from the walls of the horn chamber. The reverberation period of the horn chamber should be negligible. The horn chamber should be properly designed and aligned with the splays previously mentioned. The walls should be built to prevent the structural transmission of sound, and they should be well treated with suitable acoustic material so as thoroughly to damp and absorb sound of all frequencies.

It is the opinion of the authors that in an auditorium specially designed for film presentation a stage as such is not desirable, and a dummy stage is an anachronism. Where, however, it is considered necessary to provide a stage, it is particularly important that the flooring be strongly reinforced, and that its upper surface be covered with acoustically absorbent material so that it does not become a source of low frequency resonant effects.

Furnishings

The question of furnishings has a material effect upon the sound quality. Gangways and aisles should invariably be carpeted, and heavily underfelted. The chairs should be well upholstered, particularly the backs. If sufficient attention is paid to these matters, the numbers of persons present in the auditorium should not have a marked effect on the acoustic characteristics, at least between one-third and full audience. It is most desirable that the acoustic conditions in the auditorium remain uniform, and every endeavour should be made to minimize changes due to variation in the number of the audience.

4. CONCLUSION

In presenting this design, the authors are of the opinion that little or no acoustic treatment of wall surfaces will be required and all objectionable sound reflections will be obviated by proper diffusion. In kinemas seating less than 1,000 persons this should always be accomplished ; in larger auditoria seating between 1,000 and 1,500 it should be possible if these recommendations are carried out ; but in the largest theatres the application of some acoustic material on the wall surfaces may be necessary. When this is required, it should be provided in the form of strips or panels of limited area, which should be spaced asymmetrically about the side walls.

Concentrated areas of acoustic material are to be avoided. Although leading to the same final reverberation time, the initial decay processes are dissimilar, and it is these initial stages of the decay period that are important for superlative sound conditions.

It appears that it is during the first few milliseconds of the reception of a sound that the human ear assesses its direction of approach and frequency response ; and thus, whilst a satisfactory overall reverberation time is essential for good listening conditions and for intelligibility of speech, the initial frequency characteristics of the decay period are of equal, if not greater, mportance.

DISCUSSION.

Mr. J. L. Stableford : What is going to happen to the tabs. and drapes if no proscenium is provided ?

Mr. L. Audigier : They are not necessary to the modern kinema, and should be dispensed with.

Mr. J. L. Stableford : I doubt whether the exhibitor will agree to lose the decorative effect of a proscenium.

A Member : A convex back wall might detract from the appearance of the auditorium, and furthermore would probably add to the cost of construction.

Mr. A. P. Castellain : The convex wall might assist in providing space for lobbies and offices, and upstairs for the projection room.

A Member : Would not the auditorium be acoustically more satisfactory if a reverse rake were given to the stalls floor level ?

Mr. L. Knopp : It would be objectionable, not from the point of view of sound, but from the point of view of the comfort of the patron. The seat may, of course, be raked back to provide a satisfactory viewing angle, but in this case seating capacity will be considerably reduced.

Mr. S. T. Perry : My experience has been that most of the older theatres, with several circles, had better acoustics than the modern kinema auditorium.

Mr. R. H. Cricks : How was the illustration of the sound waves in auditoria (Fig. 8) produced ?

Mr. L. Knopp : It was produced in a ripple-tank by means of models.

INDUSTRIALISTS' REPORTS ON GERMANY

A revised list of intelligence reports on German industry (some of which marked * were summarised in a recent issue of the *Journal*) is now obtainable from H.M. Stationery Office, price 6d. The following will be of interest to members (prices include postage) :

CIOS XXVI–46 : Stereophonic Sound Recording System (1s. 1d.).
*BIOS 207 : " Magnetophon " of A.E.G. (1s. 1d.).
*CIOS XXVI–61 : Film Production and Methods, Agfa Film-Fabrik Plant, Wolfen (1s. 1d.).
CIOS XXX–15 : Agfa Film Factory, Wolfen (2s. 7d.).
CIOS XXX–17 : I.G. Farbenindustrie, Agfa Subsidiary, Wolfen (7d.).
BIOS 262 : German Photographic Film Base Industry (6s. 9d.).
*BIOS 397 : Agfacolor (2s. 2d.).
FIAT 528 : Light Sensitive Reproduction Materials (7s. 9d.).
FIAT 721 : Agfacolor Negative/Positive Method (3s. 2d.).
FIAT 802 : The Arriflex 35mm. Motion Picture Camera (1s. 7d.).

There is also a large number of reports dealing with chemical and metallurgical products, and with many aspects of the engineering, electrical and optical industries.

THE PREPARATION OF A FILM

Harold Huth, B.Sc. (*Member*).*

Summary of address delivered to the B.K.S. Film Production Division on February 27th, 1946.

MR. HUTH commenced his account of production at the stage where a provisional script had been agreed—not, he emphasised, the final script. The script was agreed by a conference at which the director, the art director, lighting director, and other interested parties were present.

It was essential that the art director should know exactly how a scene was to be played ; he could then design his set with the maximum of economy, not building any parts of the set that would not come within the camera angle, or would be in darkness. Every camera angle must be planned in advance. The art director would first make a sketch of the scene, and would then prepare a ground plan from which subsequent work could proceed.

One of the principal things in arranging shots was, what was going to be the reaction on the artists ? Most artists were prepared to move to a chalk-line—others were not so amenable. A certain elasticity in planning must therefore be allowed.

Planning the Action

When the plans of half-a-dozen sets were ready, a meeting was held, attended by the producer, director, cameramen, editor, if possible the camera operator, and occasionally the man who was to be in charge of the construction of the set. Mr. Huth's method of conveying and recording his ideas—not, he stressed, the only one—was to make thumbnail sketches of what the artists would look like on the set. Occasionally an artist would make sketches of the more important scenes.

Mr. Huth explained his method in detail in connection with the set of a public-house. He first showed the art director's drawing, then sketched the ground-plan, and demonstrated how the positions and movements of the characters were illustrated. In the particular scene he described, a character started an altercation with the barmaid, struck the tray of drinks from her hand, and in the middle of his frenzy, dropped dead. Mr. Huth followed in detail the movement of the barmaid from the bar to a table where the character was seated, her movement across the scene followed by the man, and his movement to the place of his fall.

The speaker advocated the use of a moving camera rather than of cutting to close-ups, which, he maintained, spoilt the continuity ; there was no reason why people should not appear in close-ups as the camera moved. The movement of the camera as it trucked diagonally across the set was drawn in, Mr. Huth explaining that he worked out the angle of the lens by means of a celluloid scale on which were marked the angles of lenses of various foci.

Estimating the Footage

Having detailed the action, the next step was to time it. The method adopted was to mime the action several times, and time it with a stop-watch. He stressed the importance of accurate timing of each shot ; in a picture there would be hundreds of set-ups, and the slightest error could result in excessive footage being shot. He estimated that in his films, 80 per cent. of material reached the screen exactly as planned, and most of the remaining 20 per cent.

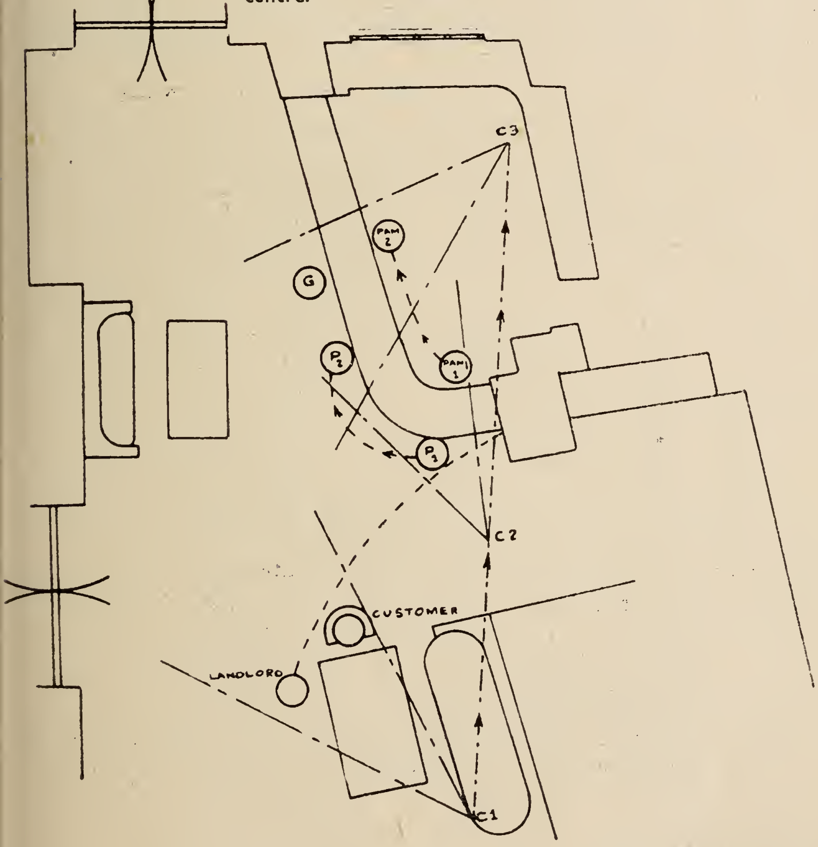
* Gainsborough Pictures (1928) Ltd.

underwent only trivial changes on the floor. The result was that little surplus footage was shot. The more detailed the shooting plan, the more accurate would be the time schedule.

The final script was produced only after all this planning had been completed. The dialogue might have to be slightly altered to suit the action. Ultimately the agreed shooting plan was passed round to the various departments.

Mr. Huth expressed the opinion that detailed planning of this nature was becoming absolutely essential to production. Without it, the cost of a picture went up enormously—and a picture was not better for time that was wasted. The principal cause of waste, concluded Mr. Huth, was lack of planning.

SCENE 76. SET-UP 1. M.C.U. Landlord talking to customer seated at table in foreground. At end of Landlord's speech he takes glasses from table and moves to bar, CAM following on track to C.2 cross Perkins and include Pam. Landlord exits CAM R. (We should be able to see Grice between Pam and Perkins.) We track with Pam to C.3 as Perkins goes round on outside of counter and Pam follows up inside framing eventually with Pam R of CAM. Perkins L of CAM and Grice centre.



One of three Action Diagrams illustrating part of the Public House Scene from the film "The Root of all Evil," together with the Director's Description of the Action.

A HEAT RESISTING AND HEAT ABSORBING GLASS

Communication from Chance Bros. & Co., Ltd.

ANY normal source emitting light emits at the same time a much greater proportion of its energy in the form of invisible radiation which, while not contributing to the visual effect, is absorbed by and therefore heats up any body on which it falls. The light itself when absorbed gives rise to heating and there is therefore a natural limitation of the efficiency of a heat absorber of this type. Any glass which absorbs heat must necessarily become hot and glass on heating is liable to fracture ; it becomes essential therefore, that such a filter must have heat resisting properties as well as that in general it must be of low thermal expansion. A further requirement is that the glass which absorbs the invisible part of the spectrum shall not change the colour of the light to any appreciable extent.

As the result of a long series of experimental investigations a glass has now been produced on an unusual type of base which combines the required properties to a remarkable degree. It is virtually colourless, *i.e.*, it does not absorb or change the colour of any light falling on it, and it absorbs almost completely all the invisible infra-red portions of the spectrum which cause heating, without any disadvantage as regards the visible. This glass is known as Chance ON19.

The physical properties of the glass are indicated in the following table :

Light-Heat Transmission (for 2848° K.)		
Thickness	Light	Heat
mm.	%	%
0.5	91.3	39
1.0	90.3	23
1.5	89	19
2.0	88	14
3.0	87	8.5
4.0	85	6.5
5.0	83	5.5
6.0	81	4.5

Other properties which may be of interest to computers are :

Refractive index 1.505
ν-value 66.5
Specific Gravity 2.5
Thermal Expansion ... ... 59×10^{-7}
Annealing Temperature ... ... 550° C.
Durability : The durability is good, as no visible attack has been observed on long exposure to a damp, warm atmosphere.

Methods of Using the Glass

Since this glass has almost complete absorption of the infra-red it necessarily gets very hot in use and in spite of its low expansion serious strains can be set up, particularly when the radiation does not fall uniformly on the glass. In

a projection system the heat absorbing filter must be placed somewhere between the lamp and the film. If placed close to the lamp it will get very hot and will need greater cooling than if at a greater distance from the lamp ; on the other hand, if it is closer to the film it is likely that the heat will be concentrated on the centre and the outer edges will be relatively cool, which again leads to breakage. Also, any minor defects in the glass, such as small bubbles, may appear on the projected picture if the glass is close to the film. The best place, therefore, is somewhere near the condenser lens and preferably on the lamp side of the condensers in order that the condensers themselves shall be subjected only to cool light. In this case some form of forced cooling is probably necessary, but in such cases as those where forced cooling cannot be applied the glass filter should be put on the inside of the condenser. In either case a small gap should be left between the glass and the condenser. It is frequently an advantage to cut the glass into strips as this minimises the stresses due to uneven heating, but in such cases care must be taken that the edges are smooth and the glass must not be mounted so tightly that it is fractured from this cause.

Owing to the particular and peculiar nature of the glass used for Chance ON19, it is impossible for it to be moulded or provided in other shapes than the flat glass indicated above.

BOOK REVIEWS.

TWENTY YEARS OF BRITISH FILM, by Michael Balcon, Ernest Lindgren, Forsyth Hardy, and Roger Manvell. The Falcon Press. Price 10*s.* 6*d.*

Here are the beginnings of what might have been a very significant volume on the subject of British Film. Unfortunately, in its literary content, it goes so far and no farther. It divides itself sharply into four compartments. By way of introduction, Michael Balcon sounds a wise and timely warning for the future of the British quality film.

Ernest Lindgren writes on the early feature film, and is responsible for an extremely interesting analytical exercise concerning the early Quota period. He mentions quickly seventy-two film titles, all outstanding in their time and all well remembered. Twenty-six of these are associated with Michael Balcon and twelve with Sir Alexander Korda. Directorial credits constantly recurring are Hitchcock, Asquith, Forde, Saville and Wilcox. Is it that the period is now sufficiently in retrospect for the sterling service rendered British Films by this small group of producers and directors to be at last fully recognised and acknowledged ?

Forsyth Hardy's chapter on the British documentary film traces quickly the beginning, growth and acceptance of this significant aspect of production without which the British Film would be incomplete.

Lastly, Roger Manvell, whose literary efforts on behalf of the industry are becoming prodigous, summarises the situation during the war years and brings the reader up to date ; at the same time adding another word of warning for the future.

The whole is more than adequately seasoned by a remarkable series of stills covering production from " Blackmail " (1929) to " Painted Boats " (1945), incidentally proving that out of the welter of inferior product between 1929 and 1939 the British quality film emerged and commands nostalgic remembrance.

A volume to recommend as a spring board for students of the British kinema, as well as to authors and lecturers whose memories require a quick and easy prompt. Nevertheless, there remains the regret that the literary content of this well produced book was not more fully developed.

John Croydon.

CLASSIFICATION, APPRAISAL AND GRADING OF SCIENTIFIC FILMS. Scientific Film Association. 18 *pages. Price* 2*s.* 6*d.*

This publication sets out in detail a system of recording information about motion pictures of a scientific character. There is evidence that considerable thought has been given to this and it is to be hoped that such a system will be generally adopted throughout the world, to facilitate the use

and interchange of scientific films.

The compilers have left very little room for criticism, but it is possible that the terms " Interiors " and " Exteriors " could give a more exact meaning than the expressions " in Studio " and " on Location " which are used in the text. Also as an alternative to " time lapse " we prefer " Single picture photography " rather than the words " Stop Motion photography."

In practice the assessment of photographic and sound quality may present some difficulties. It is sometimes difficult to give correct answers without checking back to the original and there will be times when this check is not possible. This decision should obviously be given by a properly qualified film technician.

If the principle of " appraising " films is accepted an interesting point arises in connection with scientific films. Such films usually go through more than one phase—a period of usefulness—a period of decay—and sometimes a period of historical value. Some provision seems desirable to record the need for subsequent appraisals to decide if films are out-dated, or only of historical interest. In some cases the subsequent " appraisal " may indicate the need to scrap the film in its entirety.

This publication outlines a sincere effort to establish some order in the use and distribution of scientific films, and for that reason it should be studied by those who are engaged in making, distributing or using scientific films. W. BUCKSTONE.

ADDRESSING THE PUBLIC, by P. J. Walker (Acoustical Manufacturing Co., Ltd. 3/6).

This hand-book on public address work is intended mainly as a practical guide to those entering this field who already have a moderate knowledge of electrical theory. The functions and capabilities of amplifiers and accessories are explained without probing into the underlying theory, and many operational hints are given.

Chapters dealing with installation and operation on various types of location, both interior and exterior, will be of particular interest to mobile kinema operators, but the 120 v. line system of load matching (used on large P.A. installations) will be unfamiliar to technicians who are used to the fixed-impedance line system used in film work.

N. LEEVERS.

NATURE AND MY CINE CAMERA, by Oliver G. Pike. Focal Press. Price 15*s.* 6*d.* 226 *pages of text. Index* 2 *pp. Table of contents.*

This is a companion volume to *Nature and My Camera*, a book by Mr. Pike that dealt with the same kinds of subject, but for the still photographers.

The high standard of the first book is continued in the second and gives the reviewer as much pleasure both in the reviewing and in subsequent readings. Mr. Pike has a free and direct style that brings him and his charming sitters right to the reader's chair. Love you not Nature? Enjoy then the samples of Mr. Pike's art for the sake of their intrinsic beauty. Chapter 6 is to be taken to heart by all novices in this patience-testing business, the examples of script, commentary and shooting list show how these things should be done, and the extracts from films make one wish that the films could be reviewed at the local picture palace in a sort of repertory programme from time to time; news-reel theatres might like to use this idea.

Beauty and art are wedded here and the stars are unspoiled; not concerned with camera angles and make-up. This is a book to treasure and read and then re-read.

L. J. HIBBERT.

LE LIVRE D'OR DU CINEMA FRANCAIS. 1946. *Edited by Marc Pascal. Agence d'Information Cinégraphique, Paris.*

In this year book, two-score members of the French film trade between them paint a comprehensive picture of the industry, and of its development during and in spite of the Occupation. The bulk of the material is devoted to films, and is illustrated by a large number of excellently reproduced stills. Chief practical interest of this section is its indication of the wide field covered by French production, and its frequent novelty of outlook.

The principal interest for the technician is an article by A.-P. Richard, in which he surveys the technical facilities in material, equipment, sound and colour available to the French producer. R. H. CRICKS.

FELLOWSHIP COMMITTEE

THE first meeting of the Fellowship Committee was held on February 13th, 1947, at the Waldorf Hotel, and was followed by an informal dinner.

Unfortunately two of the fifteen elected Fellows were absent: Mr. W. M. Harcourt was in the United States, and Mr. C. H. Champion was otherwise engaged in connection with the fuel crisis. Two Members who had materially assisted in the formulation of the Fellowship proposals had been invited to join the Committee: Messrs. R. T. Dealey and Rex B. Hartley.

The Committee feels that it is expressing the wish of the Membership in ensuring that the Fellowship shall be an exclusive distinction, conferred only upon outstanding technicians. The Honorary Fellowship is an even higher award.

The Committee is to meet at regular intervals, and as soon as its proposals have been finally agreed, and have been approved by the Society's solicitor, they will be made available to the Membership.

The first meeting of the Fellowship Committee : Left to right (seated) : Messrs. E. Oram, I. D. Wratten, A. G. D. West, and P. H. Bastie. (Standing) : Messrs. Rex B. Hartley (a co-opted member), L. Knopp, R. H. Cricks, G. B. Harrison, P. G. A .H. Voigt, G. Parr, A. W. Watkins, C. Cabirol, W. Buckstone, and R. E. Pulman.

AMERICAN STANDARDS

Among recent accessions to the Society's library is a set of 26 standards on kinematography, issued by the American Standards Association, and compiled by the S.M.P.E. They include dimensional standards for 35 mm., 16 mm., and 8 mm. film, mechanical components, projection room standards, screens and screen brightness, test films, and methods of making tests.

The standards are not available for borrowing.

TECHNICAL ABSTRACTS

Certain of the following abstracts are reprinted by courtesy of Messrs. Kodak Ltd. Most of the periodicals abstracted may be seen in the Society's Library.

HIGH-SPEED KINEMATOGRAPHY.

F. C. Johansen, *J. Inst. Mech. Eng.*, Vol. 152, September, 1945, pp. 224–225.

A general review of high-speed kinematography is given, with brief descriptions of the Vinten, Zeiss-Ikon and Kodak high-speed cameras. S. C.G.

A HIGH-SPEED KINEMATOGRAPH CAMERA.

P. S. Henry, *J. Sci. Instruments*, Vol. 21, August, 1944, pp. 135–141.

The camera described takes 120 pictures on 35mm. film, at a rate of 1,500 per sec., by using a combination of a rotating drum and a series of sparks. S.C.G.

HARNESSING TIME AND MOTION BY MEANS OF HIGH-SPEED PHOTOGRAPHY FOR INDUSTRIAL RESEARCH.

H. D. McLarty, *Iron and Steel Engineer*, Vol. 21, December, 1944, pp. 70–73.

An account and a discussion are given of the use of a high-speed camera capable of exposing from 900 to 3,200 frames per second. Problems are presented in pure research, and in the practical fields of visual education, sales and promotion ; engineering studies made with this camera on the design, operation, and performance of machine tools and various mechanical devices are described. E.P.W.

THE RAW STOCK SCHEME.

Colonial Cinema, Vol. 3, December, 1945, pp. 76–79.

A description is given of the scheme under which the Colonial Film Unit sends 16mm. film stock to colonial officers equipped with suitable apparatus. The use of the film is left to the local film-making committees which can, if desired, submit scripts to the unit before shooting. All exposed film is returned to Britain for processing and editing. Mention is made of work on the deterioration of film in the tropics, carried out in collaboration with Kodak Ltd. It is intended to increase the use of colour film. G.A.J.

TELEVISION AND THE KINEMA.

G. Parr, *Phot. J.*, Vol. 85B, September–October, 1945, pp. 94–96.

The methods of presentation and production of kinema and television programmes are compared. It is stated that if the quality of television is improved, television in the home might be considered a complement to, rather than a competitor of, the kinema. The use of film in the production of television programmes is considered to be uneconomical, except as a recording medium. The use of television in the kinema is restricted at present by technical difficulties in obtaining adequate screen brightness. Recent attempts at increasing screen brightness include the use of a Schmidt optical system producing a highlight brightness of 5-ft. lamberts on a directional screen (cf. Soc. Mot. Pict. Engnrs. standard of 7 to 14-ft. lamberts), two methods using electron scanning, and one using mechanical scanning, all of which may employ a high-intensity light source. Screen brightness values for these methods are not quoted. In the discussion the author stated that the definition of a television picture of 600 lines was comparable with that of the 16mm. ciné system. J.L.T.

VARIATION OF CONTRAST WITH WAVELENGTH.

E. P. Davey, *Phot. J.*, Vol. 85B, November–December, 1945, pp. 127–128.

The variation of contrast of a photographic plate with wavelength is due to strong absorption by the silver halide between 250–310mμ, which restricts the light action to a region near the emulsion surface, thus resulting in a fairly low contrast. Above 310mμ, absorption decreases with increasing wavelength, which allows greater penetration of the light, and hence a higher contrast. This variation in absorption results also in less scattering, and so in higher resolution at the lower wavelengths. The addition of suitable absorbing substances to the emulsion can increase the absorption at the higher wavelengths without materially affecting that at the lower wavelengths, so giving rise to a more uniform contrast through an extended wavelength range.

WIDE-RANGE LOUDSPEAKER DEVELOPMENTS.

H. F. Olson and J. Preston, *J. Soc. Mot. Pic. Eng.*, Vol. 47, No. 4, October, 1946, p. 327.

In the course of developing a new dual loudspeaker of wide frequency response, a number of alternative arrangements and designs were tested. Performance details are given of several of these and also of the final design. A major difficulty in some designs is phase displacement between the outputs of the two radiators near the cross-over frequency, and the final design minimises this by using two separately driven cones placed congruently one inside the other. N.L.

FACTORS GOVERNING THE FREQUENCY RESPONSE OF A VARIABLE-AREA FILM RECORDING CHANNEL.

M. Rettinger and K. Singer, *J. Soc. Mot. Pic. Eng.*, Vol. 47, No. 4, October, 1946, p. 299.

Due to the scale distortion effect, electronic limiters used in sound transmission systems tend to modify the frequency response as well as the gain. The paper examines the desirable characteristics for the system required under various conditions of use and after deducing the total equalisation required apportions the amounts to be applied at suitable stages in the system.

The frequency characteristics and timing circuit of the compressor are dealt with in some detail and a series of studio tests described. N.L.

LA SOURCE HOMOGENE.

G. Lechesne, *La Technique Cinématographique*, No. 32, 28th November, 1946.

The author criticises normal methods of sound reproduction in auditoria, stating that the directional properties of loudspeakers give rise to reverberation patterns which are a major drawback. Suggested designs for non-directional loudspeakers include a corner horn, a folded horn, and an arrangement using reflection from a solid kinema screen. N.L.

RCA MARKETS NEW RECORDING GEAR.

Kine. Weekly, December 19, 1946, p. 300.

Newly developed 35mm. and 16mm. recording channels (including a single-film news-reel recorder) are described. The tracks may be either standard duplex or Class B push-pull. A re-recording system comprises two combined picture and sound heads, interlocked with a number of sound heads. R.H.C.

WESTERN ELECTRIC'S PORTABLE 35MM. 100MIL RECORDER.

Kine. Weekly, December 19, 1946, p. 301.

A portable recording channel embodies a sealed magnetic light valve, and can be readily converted to 16mm. recording. The conversion necessitates merely the substitution of the film feed mechanism and a movement of a switch to change the equalisation. R.H.C.

HOW THE "WATERLITE" 16MM. DIRECT RECORDER OPERATES.

D. W. Aldous, *Kine. Weekly*, December 19, 1946.

A glow-lamp 16mm. recorder embodies a fluid flywheel smoothing device, and can be quickly converted to play-back or re-recording. Recording can be performed on positive, negative or reversal stock, the last being preferred. R.H.C.

CHARACTERISTICS AND APPLICATIONS OF CONCENTRATED-ARC LAMPS.

W. D. Buckingham and C. R. Deibert, *J. Soc. Mot. Pic. Eng.*, November, 1946, p. 376.

The concentrated-arc lamp is an arc lamp provided with permanent electrodes which are sealed into an argon-filled glass envelope. The light source is a sharply defined luminous disc on the end of a specially prepared zirconium oxide cathode. The radiation has a gray body distribution with the superimposed atomic spectra of zirconium and argon. In the various sizes of lamps now made the light-emitting spot ranges from 40 to 100 candles per sq. mm. in brightness and from 0.003 to 0.06 in. in diameter.

Small-sized lamps furnish a close approach to a point source and have application in optical testing and demonstrating. Medium-sized lamps make increased detail rendition and depth of focus possible in microscopy and the photographic enlarger. Large-sized lamps are applicable in the field of projection. AUTHORS' ABSTRACT.

THE COUNCIL

Meeting of January 8th, 1947

Present : Messrs. I. D. Wratten (*President*), E. Oram (*Hon. Secretary*), R. B. Hartley, L. Knopp, S. B. Swingler, A. W. Watkins, A. G. D. West (*Past President*), W. Buckstone (*representing Sub-standard Division*), B. Honri (*representing Film Production Division*), and R. H. Cricks (*Secretary*).

Educational.—In response to a request from a Student, it was agreed to ask the Education Committee to prepare a scheme for the award of a two-year scholarship, tenable at the Polytechnic, Regent Street.

Mr. West reported that he and the Secretary were attending a meeting the following day at the British Film Producers' Association, when the formation of an Education Council for the Industry was to be discussed by representatives of employers' organisations and trade unions. It was agreed that, while the Society would be happy to co-operate in any proposed Council, it was not prepared to lessen its educational activities.

Five-year Plan.—Mr. Wratten reported that the Five-year Plan of Progress of the Society he would present as his Presidential Address.

Journal.—Arrangements for a change of printer (due to the present firm being unable to undertake a monthly issue) were reported. The President gave the assurance that no change of title or cover, as was contemplated, would take effect without the approval of Council. In order to raise the standard of published Divisional papers, the recommendation of the Journal Committee that Divisions be asked to appoint Advisory Representatives was confirmed.

Film Mutilation.—It was reported that an interim report of the Film Mutilation Committee was being circulated.

Papers Committee.—Under Standing Orders, the following were due to resign from the Papers Committee : Messrs. E. Oram, A. W. Watkins, and A. G. Penny. The following were appointed in their places : Messrs. E. D. Eyles, B. Honri, and L. C. Jesty.

Branch Constitution.—The Constitution Committee was re-appointed for the purpose of preparing a constitution for Branches of the Society, the members being : Messrs. A. G. D. West (*Chairman*), C. H. Champion, E. Oram, and I. D. Wratten.

Fellowship Committee.—It was agreed that the Fellowship Committee should meet on February 13th, and that the meeting should be followed by an informal dinner.

Meeting of February 5th, 1947

Present : Messrs. I. D. Wratten (*President*), P. H. Bastie (*Hon. Treasurer*), C. Cabirol, C. H. Champion, R. B. Hartley, A. G. D. West (*Past President*), C. H. Bell (*representing Theatre Division*), W. Buckstone (*representing Sub-standard Division*), and R. H. Cricks (*Secretary*).

Patron Membership.—The following committee was appointed to deal with the Patron Membership : Messrs. Oram, Hartley, and Knopp.

Educational.—Meetings of a committee to prepare a constitution for an Educational Council for the Film Industry were reported. The B.K.S. had been in the position only of an observer.

Fellowship Committee.—Arrangements for the meeting of February 13th were confirmed. It was agreed to invite Messrs. R. T. Dealey and R. B. Hartley.

Papers Committee.—In the absence abroad of Mr. Harcourt, it was agreed to ask Mr. Knopp to act as chairman of the Papers Committee, and to call an early meeting.

Library.—It was reported that Mr. G. A. Jackson had offered to attend the Library on Monday evenings, and had accordingly been co-opted to the Library Committee. The Committee had suggested that each Division should appoint a representative. It was also reported that arrangements had been made for the library of the Television Society to be installed on the Society's premises.

Foreign Relations.—In accordance with a recommendation from the Foreign Relations Committee, the desirability of adopting the metric system in all equipment was agreed. It was decided to communicate this view to the British Standards Institution and to the Decimal Society.

Branches.—A meeting of the Constitution Committee was arranged for the purpose of preparing a constitution for branches of the Society.

Fellowship and Membership Certificate.—Draft certificate was considered, but a decision as to its adoption was deferred.

Screen Brightness.—It was reported that the Theatre Division Committee had approved a draft standard for " Screen Brightness for Projection of 35 mm. Film." It was agreed to

confirm this approval to the B.S.I.

Physical Society Exhibition.—It was reported that the Physical Society had offered accommodation for the period of their exhibition in April, and it was proposed that technical exhibits be displayed, and at intervals a programme of scientific films should be shown. Participation of the B.K.S. in the exhibition had accordingly been confirmed.

Technical History.—A proposal from the British Film Institute, that a technical history of the Industry should be prepared, was supported.

Film Strips.—A request from the Ministry of Education that film strips used at meetings of the Society should be placed in the care of the Ministry was agreed.

EXECUTIVE COMMITTEE

Meeting of January 8th, 1947

Present : Messrs. I. D. Wratten (*President*), E. Oram (*Hon. Secretary*), and R. H. Cricks (*Secretary*).

Elections.—The following were elected :

John Hamburgh (Member), R.A.F. Cinema Corporation.
Cecil Leonard Overnell Cattermoul (Member), Cecil Cattermoul, Ltd.
John Peter Wells, O.B.E. (Associate), Technicolor, Ltd.
Geoffrey Gulliver (Associate), Granada Theatres, Ltd.
Maurice Maxwell Dawe (Associate), Dawe Bros., Ltd., Newcastle-on-Tyne.
Rudall Charles Victor Hayward (Member), Director-Cameraman, New Zealand.
Robert Benjamin Paine (Member), Ernest F. Moy, Ltd.
David Leslie Werschker (Associate), Technicolor, Ltd.
John Palmer Sayer (Associate), Catlin's Mobile Cinemas, Ltd.
Terence Kelly (Member), African Theatres, Ltd.
George William Stanwix (Associate), Kodak, Ltd.
Christopher Herbert Towle (Student), British Pictorial Productions, Ltd.
John Athol Burnett (Associate), Film Section, Admiralty.
Baron Victor Aingworth (Associate), Gainsborough Pictures (1928), Ltd.
Alfred Robert Witcomb (Member), Gainsborough Pictures (1928), Ltd.
Thomas Earle Knight (Associate), Pinewood Studios.
Reginald Stephen Ernest Thorpe (Member), Odeon Theatres, Ltd., Glasgow.
Richard Henry Bomback (Member), Pathé Pictures, Ltd.
Owen Franklin Albright Gollings (Associate), Film Section, Admiralty.

Transfers.—The following Associates were transferred to Membership :

James Neil, Photographer-Director, Glasgow.
Lionel Banes, Ealing Studios, Ltd.

Resignations.—The resignations of the following were regretfully accepted : Messrs. H. R. Shilling and H. de A. Donisthorpe.

Death.—The death of Mr. Edward Godal was noted with regret.

Accountancy.—Details of an improved system of accountancy were approved.

Staff and Equipment.—An increase of staff, and purchase of the necessary equipment, were authorised.

Meeting of February 5th, 1947

Present : Messrs. I. D. Wratten (*President*), P. H. Bastie (*Hon. Treasurer*), and R. H. Cricks (*Secretary*).

Elections.—The following were elected :

Herbert Kenneth Paul (Member), Herbert Paul (Photos), Ltd.
Gilbert Murray (Associate), British Tricolour, Ltd.
Gilbert Oswell Simpson (Associate), Palladium Cinema, Patricroft, Manchester.
Eric Thomas Merry (Student), Polytechnic, Regent Street.
Kenneth Courtney Wiles (Associate), Bushey Films, Ltd.
Helen Rosemary Dunt (Member), Pathé Pictures, Ltd.
Stefan Severin Fraenkel (Associate), formerly Technicolor, Ltd.
Robert Harold Arthur Staniforth (Associate), E.T.T. College, Coventry.
Alan James Blay (Associate), British Lion Films, Ltd.
Cyril Henry Page (Associate), British National Films, Ltd.
Alistair Fraser Ross (Student), Polytechnic, Regent Street.
Frederick Archibald Young (Member), M.G.M. British Studios.
John William Herbert Kemsley (Associate), Religious Films, Ltd.
Gaston Ludwig George Charpentier (Member), G.B.I. Imperial Studios.

Henry George Barker (Member), Denham Laboratories, Ltd.
Ernest Maurice Askew (Associate), Imperial Studios, Elstree.
Albert Howard Anstis (Member), Ross, Ltd.
Kenneth Allerton Cameron (Member), Crown Studios.

Transfers.—The following Associates were transferred to Membership :
Alexander Strasser, Realist Film Unit.
Herbert Stuart Hampson, Co-operative Wholesale Society, Manchester.

Accountancy.—The appointment of Mr. J. Foster as auditor was agreed.

Czech Film Week.—An invitation from the British Film Institute to guarantee part of the cost of a Czech film week was considered, but it was felt that this did not fall within the constitution of the Society.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of the Journal.

F. E. Bowles has started business on his own account as an engineering draughtsman.

C. Cabirol is now in the United States.

C. H. Champion has been seriously ill

Baynham Honri has been appointed studio manager at Ealing Studios.

Alan Newing has recently paid a visit to Scandinavia to investigate the market for British kinema equipment.

Geoffrey Parr has acted as consultant on a film on electronics, prepared by Ediswan.

David M. Robson has resigned from the Victor Animatograph Corporation.

W. Stanley-Aldrich has started a factory in this country for the manufacture of Strong arc lamps.

R. Watkins-Pitchford has returned from a visit to South Africa.

F. Watts has joined M.G.M., in charge of their forthcoming news-reel.

Eric Williams is shortly leaving for an extended stay in Australia.

THE JOURNAL OF THE
BRITISH KINEMATOGRAPH SOCIETY

Vol. 10. No. 3. MAY and JUNE, 1947

BRITISH KINEMATOGRAPHY

The Journal of the British Kinematograph Society

As previously announced, the Society's *Journal* will, from the July issue, be published monthly. A long outstanding aim is thus achieved, which will be to the benefit especially of those members who live outside the area of the London headquarters and the two provincial sections, and to whom the *Journal* is therefore the principal advantage of membership. This greater frequency of publication will enable reports of meetings to appear earlier than has been possible of recent years.

The proposals of the Journal Committee embrace more than an increase in frequency of publication. It has during the past year become apparent that there is a wide demand for the *Journal* from manufacturing firms catering for the industry, technical and scientific libraries, Government departments, and many persons and bodies, chiefly overseas, who for various reasons are not members of the Society. The circulation of the *Journal* has, in fact, quintupled over pre-war figures.

The Journal Committee is anxious to encourage this external circulation, holding the view that it may play a valuable part in extending the work of the Society.

Coincident with the inauguration of monthly publication, certain changes in policy will take effect. While the more frequent publication will enable the proceedings of the Society to be more fully reported than at present, the *Journal* will cease to be devoted exclusively to such proceedings, but will also carry technical papers contributed to the *Journal*, but not delivered to the Society. The Journal Committee will at all times be glad to consider publication of papers which, while of general interest, are not suited for delivery at a meeting, *e.g.*, papers of a mathematical nature.

The widening of scope of the *Journal* demands a broader title. As from the July issue, the title will be altered to *BRITISH KINEMATOGRAPHY*

A new design of cover will appear, indicative of the progressive outlook of the Society, without sacrifice of the dignity which characterises the present cover.

It is confidently expected that the new publication will play a valuable part in promoting the advancement of kinematograph technology.

NOTICE TO LIBRARIANS

In view of the change in title, it has been decided that the present volume, Volume 10, shall contain only three issues, of which the present is the last.

Future volumes will contain six monthly issues, the July, 1947, issue commencing Volume 11.

MOTION PICTURES IN THE OPERATING THEATRE

W. Buckstone (Fellow)*

Read to the B.K.S. Sub-Standard Film Division on May 22nd, 1946

IMPROVEMENTS in photographic materials, cameras and lighting equipment have each in turn contributed to a simplification of the job of making motion picture records of surgeons at work in the operating theatre.

It was during the ten years between 1929 and 1939 that the greatest advances were made in the production and use of surgical films. The major problem in these early days was to provide enough light from portable equipment sufficiently clean in design and small in bulk to be introduced into the operating theatre.

Lighting Equipment

A suitable type of lamp manufactured by Zeiss consisted of a 24 inch mirror which projected an intense beam of light from a 500 watt electric lamp. Means were provided to focus the beam and when properly adjusted it gave even illumination over an area of four square feet, sufficiently large for all shots of the operative field. In addition to the Zeiss searchlight, two floor stands were used, each with two 500 watt lamps in reflectors, placed one on either side of the camera to give a general flat lighting, with the Zeiss lamp at one side of the camera to give some degree of modelling.

The introduction of the Photoflood lamp allowed us to modify our lighting equipment, and after some experiments we decided to dispense with the Zeiss searchlight and standardise on four No. 1 Photoflood lamps in Kodaflectors. Later, we developed a series-parallel control switch for the Photoflood lamps which allowed the camera to be focused and positioned without the heat and glare of full Photoflood lighting.

Camera Equipment

At the start it was necessary to use a 35 mm. camera, as the orthochromatic film available for 16 mm. cameras was too slow. My first twelve medical films were shot with a 35 mm. Pathé camera, loaded with panchromatic negative. To prevent the tripod legs slipping on the hard floor of the operating theatre a tripod base was used consisting of three strips of wood which formed a triangle and held the tripod legs securely. This tripod base was fitted with "domes of silence," which made it easy to move the camera about.

The Pathé Camera was fitted with an iris on the mask box and use was made of this to open and close sequences. This camera was also fitted with a sliding lens panel for quick change of lenses. A 45 mm. lens was used for long shots and a 75 mm. lens for close-ups.

This made a rather bulky outfit to introduce into an operating theatre. The introduction of 16 mm. panchromatic film allowed us to make some tests with a 16 mm. camera. These tests were so successful that the Pathé 35 mm. camera was discarded in favour of a Model B Ciné-Kodak which was held in the hand.

Generally two cameras were used in the theatre so that one could be reloaded by an assistant whilst the other was in use.

Camera Technique

Visual focusing was not possible with the Model B Ciné-Kodak nor with the

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later Model K, and therefore, all lens settings had to be by scale. It is difficult for a photographer to measure the distance between his camera and the sterile field of an operation. A sterile measuring rod can be used or a length of the sterile catgut used for sutures can be attached to the camera for measuring short distances. In practice, however, we found that sufficiently accurate estimates could be made by an assistant standing at the side of the camera and able to judge the distance from a broadside view. The area included when using the one-inch lens at a distance of two feet is approximately 9 in. × 7 in., and it has been found that this size of field covers most surgical shots.

There are times, however, when it is necessary to obtain very close-up shots and to secure these, two changes in technique are required. Firstly, a lens of longer focus has to be used as the one-inch lens does not allow sufficient space between camera and subject to accommodate the surgeon's hands and lighting equipment, and, secondly, a visual focusing camera must be used to ensure critical focus and correct position. The demand for very close-up shots became insistent, and in 1931 we had no camera suitable for the work. This, of course, was before the Ciné-Kodak Special was introduced.

To overcome this difficulty I took the problem to the late Arthur S. Newman, who designed a reflex focusing system for the hand-cranked 16 mm. Model A Ciné-Kodak. This modified camera was very easy to use, pressure on a plunger bringing the reflex image into view. I can recollect two difficult jobs that would have been impossible but for Arthur Newman's reflex focusing. One of these was the photography of the vocal cords of a cat and the other occasion was when we had to show repair work on the crown of a tooth as an ultra close-up.

When the Ciné-Kodak Special was introduced in 1933 we realised that at last we had a camera completely equipped to handle all our medical problems.

Camera Stand

We had always been aware of the movement on the screen due to a hand-held camera, but experiments with tripods were not satisfactory as the splayed legs occupied far too much of the limited space around the operating table. In addition to the surgeon there are assistant surgeons, the theatre sister with her trolleys, the anaesthetist with his apparatus, nurses, etc., also one has to be very careful when moving about to avoid touching any of these people or their equipment, as all are surgically clean and must not be contaminated.

Our solution of the tripod problem was to design a pillar type stand which was adjustable for height ; the table to which the camera was attached was offset from the pillar, allowing a full 360 degrees tilt and panoram.

Experiments in Editing

By 1937 we felt that we had solved our difficulties regarding cameras and lighting, and this allowed us to devote more time to the picture. I find when reviewing our medical films taken in the early thirties that they appear to be theatrical, and this is probably due to concentrating on the story instead of the action.

Deciding that this treatment of a medical film was quite wrong, I experimented in editing a few films. As a result, I learnt that it was necessary to reduce the ordinary routine picture material in a film to short linking shots ; in some cases I even found it an advantage to omit picture material of routine jobs and use a title to maintain continuity. It must be remembered that members of the medical profession are busy people and they appreciate most the films which show the variations from normal surgical technique in full detail and at the same time reduce the ordinary routine shots to a minimum length.

Another lesson learnt was the futility of including complicated formulae in

a film. It is a clever person who can memorise formulae and retain the memory whilst viewing the following picture material.

Two Types of Films

Motion pictures of surgical operations fall in two separate groups. In Group 1 we have motion pictures for general medical exhibition and in these the operation is photographed in detail—from positioning the patient to the final dressing and removal of the patient. In some cases the picture will be extended at the start to cover premedication and anaesthesia, and at the end to show post-operative treatment. It is, of course, necessary to use the same patient and surgical team for all general shots, but close-up detail shots can be photographed on other patients, so long as the condition, aspect and surroundings match in with the adjacent shots. In this way it is possible, when necessary, to use patients most suitable for any part of the operation.

In Group 2 we have the motion pictures prepared to demonstrate variations and development in operative technique for exhibition to specialists. In this group it is usual to omit all action that is normal and generally accepted and to concentrate in full detail on the new material. In all surgical motion pictures individual shots should run for at least eight seconds, start just prior to the commencement of the movement and continue until the movement is completed.

Camera position

The preferable camera position is usually next to the surgeon as this provides the best teaching film—" As the surgeon sees it," a view over the surgeon's left shoulder will generally be best. The right shoulder position should, of course, be used with a left-handed surgeon so that the movement of the scalpel can be photographed with the minimum obstruction from the surgeon's hands.

The first shot should include some anatomical landmarks to locate the position of the patient in relation to the camera, and any change in angle should be preceded by a shot including a landmark to re-orientate the patient to the camera. Avoid any disturbing factor in the background and do not use white towels ; use green, blue, or red, preference being in this order.

Speed of Movement

Surgical motion pictures are usually photographed at distances of two to three feet and the enlargement when projected results in an apparent increase in the speed of movement. The surgeon should be restrained from working quickly, particularly during the important stages of the operation.

Selection of Film

The best film for black-and-white results is fast, reversal panchromatic film. A fast film may give more " grain " than a slower material, but will allow the lens to be stopped down, and so secure greater depth of focus. In practice the advantage in grain size when using a slower film is more than counterbalanced by the slight unsharpness due to slight error in estimates of camera distance, the effect of which is more pronounced owing to the necessarily larger aperture called for by the slower film.

One hears arguments against reversal film on the ground that it is difficult to obtain a number of copies. This is a fallacy, and even if it were true, it would not apply to a surgical film as it is seldom that a number of copies are required. The idea that editing is difficult when using reversal film is also incorrect as it is just as easy to edit a duplicate as it is to edit a contact print.

Identification of Shots

Generally a motion picture of a surgical operation is photographed in

correct sequence and it is only necessary to delete unwanted sections. In such cases the only identification required is a number or letter on each film carton to ensure that the separate rolls are assembled in correct order. For more involved work, where individual sections need identification, a letter should be allocated to each separate roll of film and a number should be photographed at the start of each sequence needing identification. Numbers can be written on a card, or printed numbers such as date pads or cloakroom tickets can be used.

A record of the scene taken under each identification should be kept on the outside of the carton or on a separate sheet.

Sound Commentary

We experimented with sound for surgical films at a very early stage. The method used was to photograph the operation in the usual way allowing sufficient picture material to accommodate the commentary. The commentary was subsequently recorded on a standard twelve-inch disc and as we were only concerned with speech it was possible to use a fine-cut recording which gave us about nine minutes of speech on one side of a 12 in. disc. As we were not concerned with lip synchronisation, but only hand movements, it was possible to use quite a loose coupling between picture and sound.

At the recording session, in which the surgeon's voice was used, the projector speed was maintained at a constant rate with a stroboscope disc on the sprocket shaft of the projector. Our plan was to evolve a scheme whereby the sound for the medical film could be provided by a normal home reproducer, and we actually used an acoustic gramophone for the first demonstration to a medical audience.

The first 16 mm. medical film with recorded commentary was shown at the Royal Society of Medicine, in London, by the Medical Department of Kodak, Ltd., on June 27th, 1929. The sound was recorded by H.M.V.

To synchronise the acoustic gramophone at the side of the screen with the 16 mm. projector at the back of the hall, we first adjusted the disc speed to 78 revolutions per minute by timing it over a minute with a stop-watch. The stop-watch was then placed on a rotating table which was driven from the eight-picture sprocket shaft of the projector, and geared to make one revolution for each 120 revolutions of the sprocket shaft. In action the hand of the stop-watch moved clockwise to make one revolution in a minute whilst the rotating table driven from the sprocket shaft moved the watch in an anti-clockwise direction. If the second hand of the watch remained stationary synchronism was effective, whilst if it moved backwards or forwards it meant that the projector was too slow or too fast. Correct synchronism could always be regained by bringing the watch hand back to the zero position.

The idea of using sound with films of surgical subjects was abandoned, however, as subjects of this type are shown to varied audiences: sometimes to students, sometimes to general practitioners, and sometimes to specialists. It was found impossible to combine in one commentary the information required for these different conditions without making it too prosy, and in addition we had to face the fact that surgical operations are subject to continual improvement in detail. It is easy to insert an alternative picture sequence in a silent film, but to modify part of a spoken commentary either on disc or film is an expensive job.

Sectionalising Films

In the early 'thirties we evolved a useful method of presenting a surgical film. We happened to receive a request to film an operation for showing at a meeting on the following evening. The picture material presented no difficulty, but it was impossible to prepare captions in the short time available.

Our solution of this difficulty was to break up the film into episodes, inserting a short length of opaque film between the sections.

The film was then used by the lecturer as he would normally use lantern slides; as each section of film ended the projector would stop whilst the lecturer spoke, until, when he was ready for it the projector showed the next episode of the subject. We named these short lengths of film "animated lantern slides," and it is an interesting fact that at a recent meeting to discuss the use of 16 mm. film in medical teaching just such a method as we had planned and used twelve years earlier was put forward as the most effective way to use 16 mm. silent films for teaching.

Titles and Credits

When a surgical film has to be shown without a lecturer, titles are necessary. These titles should be explicit and each one should only deal with one statement. The long title which covers the various happenings in a length of film long before they happen is worse than useless. A multiplicity of titles may be bad motion picture technique, but it is certainly a good practice to adopt when necessary in a film which is designed to teach.

Whilst on this matter of titles I should like to make another point. In the U.S.A. the practice has been established to submit all surgical films to the American College of Surgeons for approval and a special title is issued for use with each approved film. We used our influence to avoid a similar system in this country as we felt that a motion picture was a medium for expression in the same way as the written word, and if articles and books by medical men were not subject to approval by medical organisations there was no case for putting motion pictures under this form of control.

It is, however, necessary for someone to accept responsibility for the ideas propounded in a medical film and we have always insisted on a credit title giving the name of the medical man responsible for the production, and the place where the film was made. Occasionally a medical man will object to this because he thinks it savours of advertising; when it is pointed out that his name is always printed at the head of any article he may publish and that a motion picture is but another form of publication, this opposition vanishes.

Factual Treatment

The treatment of a subject in its film form is also of interest, and here a distinction must be made between the teaching film and the propaganda film. The theatrical treatment with fades, flash-backs, dissolves, etc., is definitely wrong in a medical film. A teaching film to be effective for adults, must be factual and free from theatrical tricks or fanciful treatment.

There are three ways in which surgical technique can be portrayed. It can be shown in direct photography or if parts are difficult of access, it can be shown by means of models, with or without the surgeon's hands. For extreme conditions where even models fail use can be made of the animator's art to demonstrate details.

The Use of Colour

This brings us to a consideration of the value of colour in surgical films. There are some who favour the use of colour for each and every medical film and there is a lot to be said for this point of view. It allows the photographer to use only one sensitive material in the operating theatre.

For exposing Kodachrome Type A film, Photoflood lamps must be used. The fall-off in intensity and quality when a Photoflood lamp is used at a voltage below that marked on the lamp must be borne in mind. For example, a fifteen per cent. reduction in voltage results in nearly a fifty per cent.

reduction in light intensity, and it also cuts the blue end of the spectrum, giving a red cast to all the colours.

Hospital Routine

Now for the future. I believe the 16 mm. motion picture will be of increasing value to teachers of surgery. I also believe that complete films of operations will only be used in special cases and that for general use we shall find the short episode film to be of the greatest value to the student.

I visualise the establishment of a routine in hospitals and associated departments whereby anyone who encounters an unusual condition sufficiently interesting to show a colleague will call in the hospital photographic department to make a visual record. This record will be kept in the film library of the hospital where it will be indexed and cross-indexed in every possible way. These library shots will accumulate year by year and within a short time it will be possible for a tutor in surgery to assemble all the material he requires for his lectures from the accumulation of short episode films in the hospital library.

I also think we may soon see stereoscopic motion pictures used in the medical school, when the third dimension is required for the complete demonstration. If this necessitates, as it probably will, the use of accessories for viewing, I think the students will willingly use them to secure the additional teaching value of the stereoscopic motion picture.

The paper was illustrated by sequences from the following films :

Amputation of the Breast. } *by courtesy of the*
Blood Transfusion. } *Kodak Medical Department.*
Gastrectomy (*by courtesy of Robert Maingot, Esq.*)

DISCUSSION

Mr. Cabirol : What is the proportion of colour film in medical research ?

The Author : I should say it would be 50%. Black-and-white film is sometimes suitable for other subjects — orthopaedic subjects, for instance.

Mr. Cook : What focal length lens do you use with a hand-held camera ?

The Author : One inch.

Mr. Cook : With a parallax corrected view-finder ?

The Author: No. Instead of checking your view-finder, you check your subject. If you determine the distance apart of the camera axis and the view-finder axis, you can make the necessary correction when centring the subject in the finder.

Mr. Ross : What light intensity is used for Kodachrome " A " ?

The Author : The light consists of four No. 1 Photofloods : two lamps in reflectors being above the patient and two alongside the camera. Those four lamps are about 3 ft. 6 in. from the operative field with the lens set at *f*/2.8.

Mr. T. W. Osborn : Is any attempt made to make the camera sterile ? Does the slight noise made by the camera or the operator interfere with the surgeon ?

The Author : The camera is always wiped over before you go into the theatre. The sister will usually give you a duster which has been wrung out in disinfectant. I have on occasion been compelled to " wash up " before going into the theatre, but generally it suffices to wear a gown, mask, and overshoes. Camera noise does not give much trouble.

Mr. H. S. Hind : Are any special precautions required to reduce the heat from the lights ?

The Author : I have been told by several surgeons that cases that had been photographed seemed to heal quicker.

Mr. N. Leevers : You have referred to the tendency for close-up views of an operation to appear hurried when shown full screen size. Have you tried the use of slow-motion ?

The Author : We have tried the experiment—we have run up to 24 frames on occasion. But the best solution is to ask the surgeon to be deliberate ; it tends to improve the teaching value.

RECIPROCITY FAILURE AND SENSITOMETRIC CONTROL

G. S. Moore, M.Sc., F.R.P.S. (*Member*)*

Read to the British Kinematograph Society on 13th November, 1946.

SENSITOMETRIC control was introduced into the motion picture industry following the advent of the sound picture, and the need for more exact control in the exposure and processing of motion picture films. The Eastman type IIB sensitometer, which was made available to the industry in 1931, soon became the standard motion picture laboratory sensitometer in both America and Great Britain, and has made an important contribution to the improvement in sound and picture quality.

When Ilford Ltd. introduced their Fine Grain Release Positive, 5BW, at the beginning of 1946, it was pointed out that its characteristics relative to Eastman 1302 would be different when determined by means of the Eastman type IIB sensitometer, compared with the relative characteristics of the films when used on the printer. On the printer they were a much closer match in speed and contrast than indicated by tests made on the IIB sensitometer. It was explained that this resulted from testing the materials on a time-scale sensitometer, whereas on the printer the emulsions were exposed to a range of intensities for a constant time and that the differences in behaviour of the two films were due to differences in the extent to which they showed " reciprocity failure." However, these differences caused a good deal of confusion in a number of laboratories and it was suggested that a paper on the reciprocity failure shown by photographic emulsions and its importance in sensitometric control would be of interest to the society.

Fig. 1. Hurter & Driffield Sector Wheel.

The Characteristic Curve

A plot of density against the logarithm of the exposure is invariably used to represent the response of the photographic material and the resulting curve is known as the " characteristic curve " of the material. It has long been known, however, that the response depends to a great extent on the conditions of exposure and development, and that the resulting " characteristic curve " will not represent the behaviour of the material in practice unless the conditions of test correspond in all essential details with those occurring in practical usage.

The essential requirements for obtaining the " characteristic curve " of a photographic material are :

(1) A sensitometer consisting of a light source of known intensity and spectral composition and a means of modulating the exposure so as to produce a series of known exposures on the photographic material.
(2) Standardised conditions of development.
(3) An instrument, known as a densitometer, for measuring the densities produced as a result of this exposure and development.

*Ilford, Ltd.

The Light Source

Since photographic materials differ in their colour sensitivity the spectral quality of the light source is obviously important. The quality of light from tungsten lamps may be specified by means of their colour temperature, and sunlight is reproduced in the laboratory by the combination of a tungsten lamp run at a colour temperature of 2360° K. and the well-known Davis-Gibson filter which gives light approximating in quality to mean noon sunlight at Washington. This is the only light source which has been internationally standardised for photographic use. In the Eastman IIB sensitometer two light sources are used : a tungsten lamp run at 2360° K. screened with a Wratten 79 filter to raise its colour temperature to 5400° K., a close approximation to international sunlight, and giving an intensity of 0.75 metre candles ; and a tungsten lamp run at 2600° K. screened with a Wratten 78B filter to

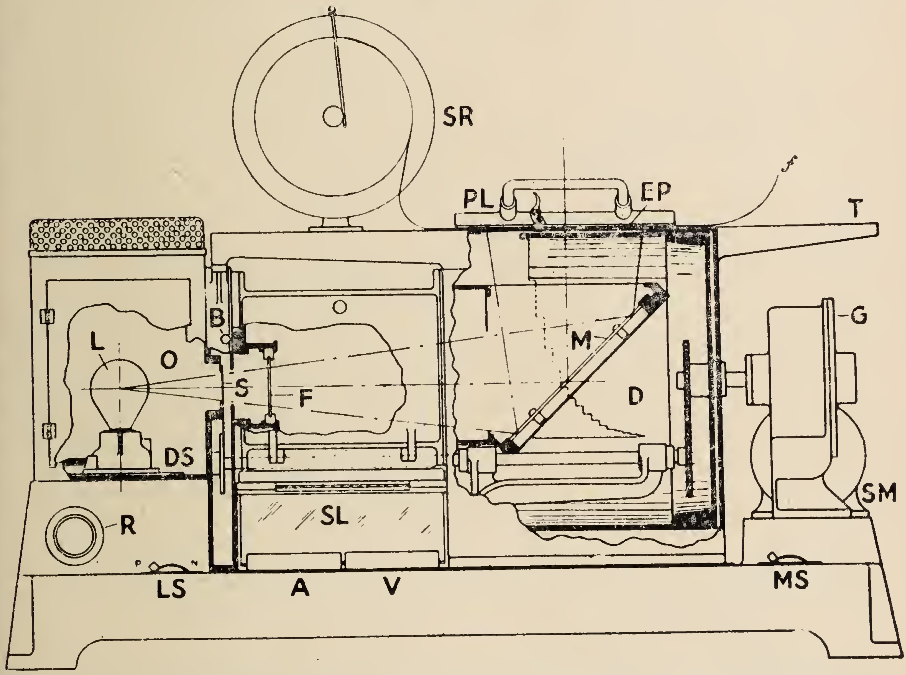

Fig. 2. Partially sectioned front elevation of Eastman Sensitometer, Type IIB. : L, Lamp : F, Filter : M, Inclined Mirror : EP, Exposure Plane : S, Shutter : D, Exposure Drum : SM, Synchronous Motor.

raise the colour temperature to 3000° K. to approximate to the colour temperature of lamps used for printing positive film and in sound recording, and giving an intensity of 27 metre candles.

Exposure Modulators—Time and Intensity Scales

Exposure being defined as the product of the intensity of the illumination on the photographic material and the time for which it is allowed to act, raises the question which of these factors is to be varied in giving the series of test exposures necessary to determine the characteristic curve of the material under test. *A series of exposures in which the intensity factor is varied is referred to as an " intensity-scale " and one in which the time factor is varied as a " time-scale."*

An example of an intensity-scale modulator is the so-called " neutral "

density wedge, and an example of a time-scale modulator is the well-known Hurter and Driffield sector wheel, Fig. 1, consisting of nine angular openings, each double the size of the preceding one, so that when it is rotated at uniform speed the material receives nine different times of exposure in ratios of 1, 2, 4, 8, etc., to a constant intensity of light. We must here distinguish between intermittent and non-intermittent time-scale exposures, since the photographic effect of a series of flashes is not in general the same as a continuous exposure equal in time to the sum of the intermittent exposures. Since to-day it is relatively easy to rotate the sector wheel slowly at uniform speed and to arrange a shutter so that the material is only exposed for one revolution of the sector wheel, all modern time-scale sensitometers are non-intermittent.

The Eastman type IIB sensitometer is a time-scale instrument, the type IIB referring to a non-intermittent time-scale, Fig. 2. In this sensitometer the exposure modulator consists of a series of 21 apertures, increasing in ratios of $\sqrt{2}$, cut in a cylindrical shutter which is rotated at constant speed close to the exposure plane by means of a synchronous motor. The material thus receives a series of exposures at constant intensity, increasing in log. time increments of 0.15 from approximately 1/200 sec. to 5 secs. when operated on a 50 cycle supply.

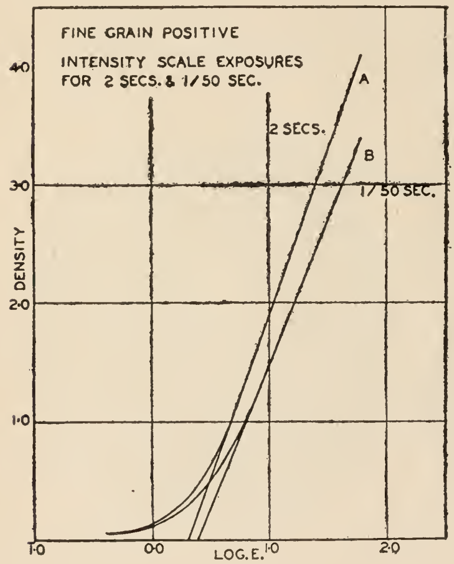

Fig. 3. Intensity-scale exposures for 2 secs. and 1/50th sec., Fine-grain Positive.

Reciprocity Law

It would be immaterial whether we used a time-scale or an intensity-scale provided a certain amount of light energy always produced the same photographic effect, no matter whether it were obtained with a weak intensity of light acting for a long time or with a higher intensity of light for a correspondingly shorter time, which is the assumption of the so-called "reciprocity law." *According to this law, equal values of light energy, measured by the product of intensity and time, falling on a photographic emulsion will always produce equal densities regardless of the absolute level of intensity at which the exposures are made.* In general, photographic materials do not obey this law and their failure to do so is known as "reciprocity failure."

Reciprocity Failure of Fine Grain Positive Emulsions

An example of reciprocity failure is shown in Fig. 3, which shows the results of giving two strips of a Fine Grain Positive film the same series of exposures, both being intensity-scale, the only difference being that curve A was obtained with an exposure time of 2 seconds and curve B with an exposure time of 1/50 second, with the intensity levels correspondingly increased. If there had been no reciprocity failure the curves would, of course, be superimposed, but it will be noted that the longer time of exposure is more efficient in producing density. For instance, an exposure of 10 metre candle seconds produces a density of 1.93 if it consists of 5 metre candles acting for 2 seconds, and only a density of 1.5 if it consists of 500 metre candles acting for 1/50 second.

It will also be noted that not only is the material faster with 2 seconds' exposure, but it is also more contrasty, having a gamma of 2.7 at 2 seconds and 2.4 at 1/50 second.

By making a series of intensity scale exposures at a range of exposure times and plotting the resulting characteristic curves, we can obtain the reciprocity curves of the material, which are usually represented by plotting the log. exposure values against the log. intensity values for given values of density. The curves shown in Fig. 4 were obtained in this way using the same Fine Grain Positive film and show the values of log. *I.t.* required to produce densities of 0.25, 0.5, 1.0, 1.5 and 2.0 respectively, for various values of log. *I*. If the emulsion showed no reciprocity failure the curves would be horizontal straight lines, *i.e.*, the exposure required to produce a given density would be independent of the intensity. It will be noted, however, that the curves show minimum values of log. *I.t.* in the region of log. $I=0.5$, with an exposure time of about 2 seconds for a density of 1.0. With higher or lower values of intensity the exposure is less efficient in producing density and higher values

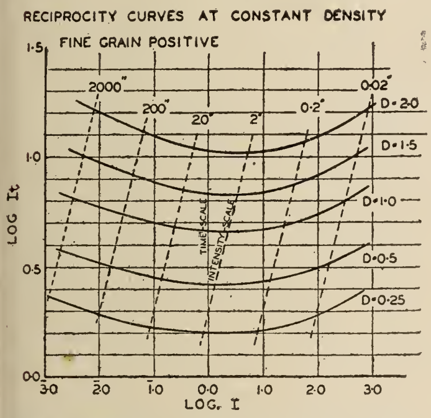

Fig. 4. Reciprocity Curves at Constant Density. Ordinates—Time-scale: broken inclined lines —Intensity-Scale.

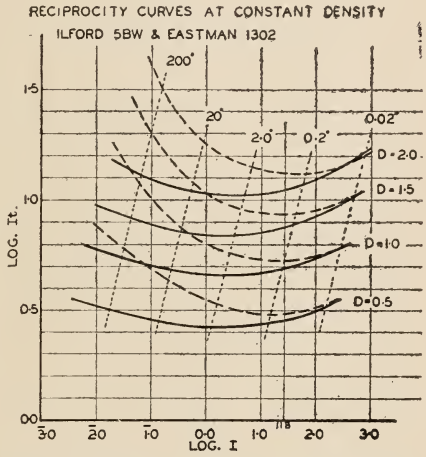

Fig. 5. Reciprocity Curves at Constant Density. Ilford 5BW (broken lines) and Eastman 1302 (continuous lines).

of log. *I.t.* are required to produce a given density. Any ordinate drawn across the curves represents the condition obtaining in a time-scale sensitometer and the broken inclined lines, being lines of constant time, represent the conditions obtaining in an intensity-scale sensitometer. In relation to reciprocity failure there are three characteristic regions of intensity :

(1) High intensity where the gamma of the time-scale is greater than the gamma of the intensity-scale.

(2) Optimum intensity where the gamma of the time-scale approximates to that of the intensity-scale.

(3) Low intensity where the gamma of the time-scale is lower than that of the intensity-scale.

Fig. 5 shows a comparison of the reciprocity curves for Ilford Fine Grain Release Positive and Eastman 1302, the broken lines being the curves for the Ilford film and the continuous lines being the curves for the Eastman film, two batches being selected which had approximately the same speed measured

at a density=1.0 when exposed to an intensity-scale for 1/50 second. It will be noted that the curves are remarkably different, the Ilford film showing an optimum intensity at about log. $I=1.5$ corresponding to a time of exposure of about 1/5 second for a density of 1.0, whereas the Eastman film shows an optimum intensity at about log. $I=0.5$ corresponding to an exposure time of about 2 seconds for a density of 1.0. Over the range of intensities corresponding to times of exposure of 1/50 second to 20 seconds for a density of 1.0 the Ilford film shows less reciprocity failure than the Eastman film, but its reciprocity failure becomes much greater than for the Eastman film for lower values of intensity.

Since the Eastman IIB sensitometer, when used for exposing positive film gives a log. $I=1.43$, we should expect the two films to show greater differences in speed and contrast when exposed to a time-scale under these conditions than when exposed to an intensity-scale for a 1/50 second. This is illustrated in Figs. 6 and 7. When exposed to a time-scale under the conditions obtaining

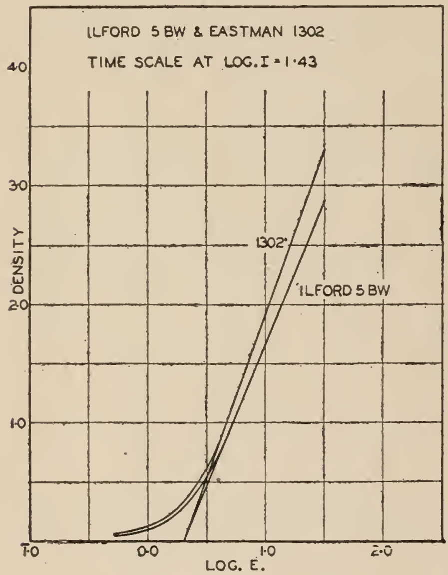

Fig. 6. *Characteristic Curves of* 5BW *and* 1302. *Time-scale at log* I = 1.43 (*IIB Sensitometer*).

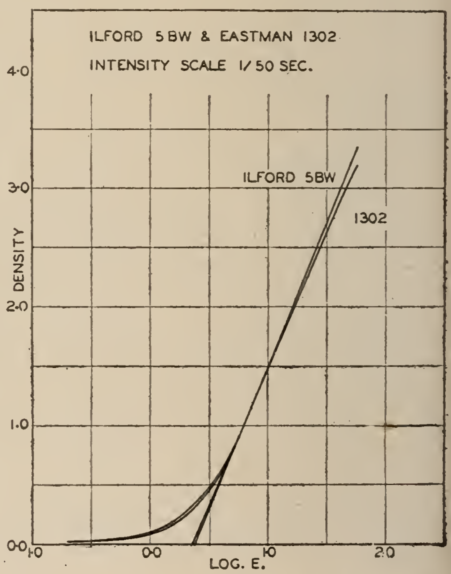

Fig. 7. *Characteristic Curves of* 5BW *and* 1302. *Intensity-scale at* 1/50 *sec.* (*Printer*).

on the IIB sensitometer it will be seen that the Ilford film, in addition to being slower than 1302, has a lower gamma, whereas to an intensity-scale exposure at 1/50 second the two films have the same speed at a density of 1.0, the Ilford film having a slightly higher gamma. When positive film is exposed through a negative on a printer it is exposed to a range of intensities for a constant time of the order of 1/100 second, which is sufficiently close to a 1/50 second for the intensity-scale exposure at 1/50 second to be a close approximation to the characteristics of the films when exposed on a printer.

All photographic emulsions show reciprocity failure and the reciprocity characteristic varies greatly with different emulsions. The exposure intensity at which maximum efficiency occurs is usually about that value for which a medium density is produced in from 1/10 second to 10 seconds, but may be as short as 1/50 second for some fast negative emulsions.

Sensitometric Control in the Motion Picture Laboratory

Motion picture films are exposed, in the picture camera or on the printer, to a range of intensities for a constant time, of the order of 1/50—1/200 second, although in some variable density sound recording cameras the moving ribbons of the light valve cause a variation in time and not in intensity at exposure times of the order of 1/20,000 second. If we are to obtain the " characteristic curve " of the material which is really characteristic of the material in practice we have seen that the test exposures must be made under the same conditions as regards intensity and time as those in practical usage. The difficulties in producing intensity-scale sensitometers to operate at the required short exposure times are firstly the much higher intensities of light required, since there is an enormous waste of light in producing a wide range of intensities, and secondly, in providing a means of modulating the intensity over a sufficient range without altering the quality of the light. So-called neutral density wedges cannot readily be made so non-selective that they do not require elaborate calibration with the type of photographic material with which they are to be used, and intensity-scale sensitometers are in consequence much more difficult to specify and calibrate than time-scale sensitometers. The latter type of sensitometer is easy to specify and can be constructed with great precision, and offers considerable advantages for sensitometric control.

The purpose of using sensitometric control in the motion picture laboratory is to enable material to be exposed and processed so that a definite desired result may be achieved. This involves developer bath control for which, although chemical analysis and *p*H measurements are a valuable aid in establishing replenishment rates, the final check on developer activity should still be by means of a sensitometric strip ; development of material to a given control gamma ; and determination of the speed of different batches of material so that due allowance can be made for batch variation.

For developer bath control a time-scale sensitometer offers no disadvantages. The required degree of development of a given type of material may also be specified by exposures made on a time-scale sensitometer where the type of exposure is rigidly specified as with the Eastman IIB sensitometer. Different manufacturers' materials may, however, require to be developed to different IIB control gammas to achieve the same degree of contrast in practice. Again, while the difference in speed between different batches of the same type of material of one manufacturer may be adequately determined by means of a IIB sensitometer, since the reciprocity failure differences between different batches is relatively small, it cannot be relied upon to give accurate information on the relative speed of different makers' products when used in practice. This would be especially the case if a IIB sensitometer were used to compare the speed of different materials required to be exposed at the much higher intensity level used in sound recording. Provided these limitations are realised the IIB sensitometer has much to recommend it as a standard instrument for sensitometric control.

One interesting development which some laboratories have been using is what is generally referred to as a " print-through gamma " strip. In the Denham Laboratories this consists of a wedge of three or four steps and a portrait, the whole occupying the 35 mm. picture frame, made on duplicating negative film by means of an optical printer. Three frames of this strip are attached at the beginning of the negative and printed at a given light change, and are used to control print quality, the IIB sensitometer being used for bath control.

In this paper an attempt has been made to indicate the nature of reciprocity failure shown by photographic emulsions and to discuss its implications in the

sensitometric control in the motion picture laboratory. There will of necessity be many points of sensitometric control with which it has not been possible to deal and it is hoped that these will be raised in the discussion.

DISCUSSION

Mr. L. H. Bacon : Is the reciprocity failure greater with fine-grain stock than with ordinary stock ?

The Author : It depends on what materials you are comparing. The reciprocity failure of some fast negative materials is quite as great as for fine grain positive.

Mr. H. Waxman : Does the inability of a photographic emulsion to integrate a series of exposures give a less density than a continuous one ?

The Author : The intermittency effect is another aspect of reciprocity failure. Whether an intermittent exposure gives a greater or less density than a continuous one depends on the intensity level, and the frequency of the flash.

A Visitor : Is it to be expected, as a result of reciprocity failure, there will be a non-linear volume characteristic in the Western Electric light valve ?

The Author : No. Although the characteristic curve of the sound negative, obtained at the relatively low intensity time-scale conditions of the IIB sensitometer, will in general be different from its characteristics in the sound recording camera, the IIB control gamma is only used to obtain a given contrast which has previously been shown to give the desired result.

Mr. R. H. Cricks : Does the colour of the light affect reciprocity failure ? I have in mind the difference in colour of light of a resistance controlled printer light.

The Author : No ; the colour of the light has no effect on the amount of reciprocity failure shown by photographic emulsions.

Mr. Felt : You mentioned that there had been difficulties over the use of the IIB sensitometer with these particular emulsions, and I take it the difficulty is that having assessed the capability of an emulsion with that particular sensitometer, it is found in practice that on the printer you do not get the results you expect. Would it not be possible for the manufacturers to quote some factor for their emulsion which would enable you to relate the figures taken on the IIB sensitometer, so that they would agree with what is found on the printer

Mr. I. D. Wratten : When Kodak produced 1302 material it gave the laboratories a development control gamma guide. If another manufacturer introduces a material matched with the Kodak product in terms of the printer, obviously situations arise when with similar gamma values obtained with the IIB sensitometer the two materials may show differences in quality. I agree with Mr. Moore that this method fails to take account of differences in reciprocity failure between the two materials.

The Author : As regards the second part of the question, manufacturers recommend an appropriate development control gamma. For the Eastman film the IIB control gamma is in the region of 2.6 or 2.8, and for the Ilford film about 2.3 to 2.6. As regards the speed factor, it is not possible to recommend the density of a given step on account of the differences in the degree of development obtained in various laboratories. We could, however, say that for a density of 1.0 with 1302, the density with the Ilford film should be 0.1 to 0.15 lower for matched prints.

Mr. M. V. Hoare : On the question of exposing strips on the IIB, the usual practice with fine grain stocks is to give two exposures : would there be any serious consequence in leaving the 78B filter out, and getting the higher intensity at the lower colour temperature ?

The Author : I do not see any advantage in giving two exposures since you can get adequate exposure on 5BW or 1302 on the IIB with the filter with one exposure. While there will be no intermittency effect between these two exposures, it is difficult for the operator to remember whether he has given one or more exposures, and this method is therefore liable to lead to errors.

Mr. Dibley : Is there any recommendation on this point, because at Denham we are having to give four exposures on 1302 material.

Mr. J. W. W. Smith : The recommendation I have made is that the IIB sensitometer should be set up and operated exactly as for ordinary positive, but instead of using, say, the tenth step as the control, you take the fourteenth step and so obtain the necessary four times increase in exposure for Fine Grain Release Positive. Thus, you do not have to disturb the instrument other than perhaps to cut notches in the mask to indicate the new position.

Mr. I. D. Wratten : I quite agree with that view.

SOME SPECIAL PHOTOGRAPHIC EFFECTS

Harry Waxman *(Member)* *

Read to the B.K.S. Film Production Division on October 23rd, 1946.

THE subject of special photographic effects as a whole being too vast and complex to cover within the limits of one evening's discussion, I propose to-night to deal specifically with three or four effects we have been recently called upon to do.

In special photographic effect work one is more often than not faced with a problem the solution of which is purely mechanical and not photographic. I use the term " mechanical " in a broad sense to differentiate from the purely photographic.

Planning an Effect

For example, the opening sequence in the recently completed Two Cities' production " School for Secrets " called for shots of an aircraft flying above the clouds. The aircraft gradually loses height until it sinks into the clouds and when completely lost from view it collides with a mountain peak and crashes in flames.

During the preliminary production meetings the treatment was decided upon, such as that the actual collision with the mountain peak should not be shown, as this would destroy much of the dramatic effect. The viewpoint from which the scene should be photographed was likewise decided upon as being seen from another aircraft flying alongside—this being about the only logical viewpoint from which such action could be seen. Also it was felt that the introduction of any camera movement that such a camera position would naturally give would also heighten the effect of realism.

After the collision and subsequent explosion it was decided that the "camera plane " should then go down into and through the clouds and there below would be seen the mountain peaks and the burning wreckage. This simple device enabled us to make a break at this point in the shooting of the scene and the two halves of the completed scene which we shall see later were, in fact, shot six weeks apart.

Camera Equipment

From the foregoing it will be seen that there were no real photographic problems to overcome. The flying camera view-point was simply solved by shooting this sequence with a hand-held camera, so that the operator could introduce the required amount of movement.

A 400 ft. model " Q " Eyemo was used for this purpose because it was capable of being run at 48 frames per second, which had been found by previous experience to be just sufficient to " iron out " any too violent camera movement. A 24 mm. lens stopped down to $f/2.8$ with Super XX stock completed the photographic combination. Incidentally, this method was used to photograph almost all of the flying model shots in this production and in the R.A.F. film " Journey Together," from which I hope to show you a complete sequence later.

Our real problem, of course, was the production of the clouds. As we were in effect going to do a tracking shot we first had to decide whether we should produce a large area of static cloud and track the camera and aircraft over it, or have a fairly static set-up and move the clouds past the camera. We decided upon the latter method as being the more practical and controllable.

* Camera Department, Two Cities Films Ltd., Denham Studios

Forming the Clouds

The various methods of producing cloud backgrounds such as B.P. photographic backings, projected clouds, etc., are too well known to need description, but it will be evident that none of these methods would be of any use to us as we wanted not only a background of clouds, but a foreground and middle distance too. In other words, it had to be " solid " clouds into which our aircraft could actually fly.

My associate, John Howell, and myself solved this problem after a small scale test was made, based on some experiments we had made together whilst in the R.A.F.

We knew that when solid carbon dioxide (CO_2), which is commercially sold as " Dricold," is placed in water, a white heavier-than-air vapour is produced which always naturally travels in the same direction—downwards. All we had to do was produce it in sufficient quantity and control it.

Mechanical Construction

A large sloping ramp (Fig. 1), measuring 18 ft. × 24 ft., was mounted on a central transverse pivot. This pivot was incorporated to allow us to arrive easily at the required angle of tilt, after which the ramp was locked off.

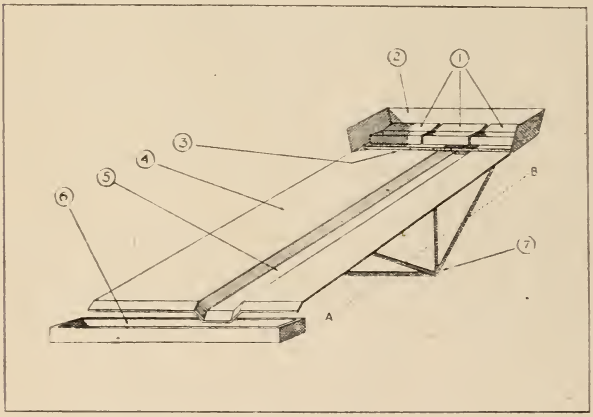

Fig. 1. Diagram of ramp.

(1) Generating Tanks. (2) Top of ramp boxed in. (3) Water Pipe. (4) Ramp 18ft. x 14ft., surface smooth and waterproof. (5) Trough. (6) Drain Trough. (7) Transverse Pivot. A to B. Direction of short camera track

(By courtesy of The Cine-Technician).

Across the full width of the ramp at the top, metal tanks measuring 6 ft. × 1 ft. × 6 ins. deep were placed, each tank containing about 4 ins. of water and being fitted with heating units. Each tank was also fitted with a hinged wooden lid which opened right back into the horizontal position. " Dricold " was broken up into small pieces and loaded on to the lids of the tanks so that it could be tipped into the water across the full width of the ramp when the water reached the required temperature. We found that 130° F. gave us the best results.

Being only 1.5 times the weight of air the vapour is very easily disturbed, so that there was a limit to how far we could tilt the ramp before the "clouds" lost their formation. As, however, they were required to travel faster than this limited tilt would allow, the top surface of the ramp was made smooth and waterproof and cold water was run down across the full width. Our clouds were now resting on a moving surface of cold water to which they seemed to adhere whilst being carried forward with a minimum of disturbance. A trough running up the full length of the ramp was provided to allow sufficient depth of cloud for the model aircraft completely to sink into.

The camera which tracked along the direction indicated by the dotted line

in Fig. 1 was tilted to " level " the shot up and the aircraft was run along horizontal wires in the usual way so that it gradually entered the clouds. Wooden baffles, of various lengths, heights, and angles, were placed here and there on the ramp to bounce the clouds up where necessary.

The camera, of course, over-shot the far edge of the ramp on to a white backing on which was projected a sky in the conventional manner, using three cloud glasses moving at slightly different speeds. No great difficulty was experienced in blending this into the " solid " foreground clouds. Fig. 2 is an enlargement from this actual shot of the aircraft flying over the clouds and as it is about to disappear into the clouds.

Crashing an Aircraft

Another shot that was called for was of a Halifax aircraft crashing on to a town after it had impacted a barrage balloon cable. The preceding shots were to show the reactions of people in the streets looking up at this low-flying aircraft and then running for shelter as they realise it is crashing.

Therefore it was obvious that the actual shot of the crash should have human beings in it. Fortunately the director wanted this shot to show the aircraft crashing behind some buildings, which made our task easy.

Fig. 2.
Aircraft just about to enter Clouds.
(*By courtesy of* The Cine-Technician).

For the sake of economy a real skyline was photographed. A full size foreground was then built with a small perspective portion on the lot at the studio, on which the artists played their action. The only important detail here was that the small amount of perspective background should come above the heads of the moving figures to facilitate the matting out. The sky portion of the same set-up carried the aircraft (Fig. 3). It was necessary to shoot this set-up in two sections because of the different camera speeds required and also because of the shadow cast by the model aircraft. These three negatives were finally combined in the projection printer by methods such as have been described by T. W. Howard. Fig. 4 shows a frame from the final combined print.

Filming Radar Masts

Another shot which at first presented an interesting mechanical problem was a descriptive shot that was required of a radar installation. The shot was required to show first a complete radar tower set-up with the base of a transmitting tower in the foreground and four receiving towers in the distant background. The camera was then required to pan round until it held only the base of the foreground transmitting tower. Then it had to

track slowly up this tower beyond the top until it held sea and sky, pan round on to the sea and sky only, with a distant ship, hold this set-up for a few seconds, then pan quickly back to a close-up of one of the distant receiving towers and travel quickly down this to the ground. This shot was obviously a model shot as the towers in question were 360 ft. and 240 ft. high respectively and were some quarter of a mile or more apart. It was decided firstly to shoot it on location, as it was realised that it would not be possible to do justice to the extensive sea and sky background necessary under studio conditions.

Half-inch scale models were made up in metal, which gave us a transmitting tower 15 ft. high and four receivers 10 ft. high. Our problem was how to manipulate the camera. A camera crane was unsuitable for two reasons. Firstly it was almost impossible to get one up to the location which had been selected, this being the top of the cliffs overlooking St. Margaret's Bay, and secondly, the speed of the pan back on to the receiving tower was too fast for a camera crane to cope with.

Camera Lift

On simple analysis the camera movement was broken up as follows: (1) a pan to the right and subsequently back again; (2) a vertical track of at least 18 ft. and subsequently quickly down again; and (3) whilst the

Fig. 3. Enlargement from preliminary test of Aircraft and foreground Set-piece.

Fig. 4. Enlargement from final Combined Print.

camera was in the top position it had to track horizontally some 50–60 feet to be in position for picking up the close-up of one of the distant receiving towers on the return pan right to left.

We solved this problem as follows. A builder's hoist such as is often seen on construction jobs was used as a camera lift. Incidentally, it was, of course, a new one purchased especially for this shot. Manipulation of this hoist was manual, assisted with counterweights, and proved most satisfactory—as you will be able to judge later when we run a complete " take." With the camera mounted on a " free " head, this combination gave us our required vertical track and the horizontal pan. The tracking of the camera was eliminated by tracking the models into position whilst the camera was on the sea and sky portion of the shot. Fig. 5 shows the camera in the foreground for the beginning of the shot. The lower half of the transmitting tower and the distant left hand receiving tower are clearly shown standing on their respective bogies, which are on rails which run out of picture on the right. Fig. 6 is a more detailed view of the camera lift.

Shooting Down a Junkers

The shooting down of a Ju. 88 as seen from behind the pilot of a Beaufighter

night fighter raised another interesting problem. This obviously was a straightforward B.P. shot; our problem was, of course, to produce the B.P. plate. Firstly, we had to see the Ju. 88 flying steadily ahead. Tracer bullets then had to be shown as coming from the foreground aircraft, in which was the camera, the engine of the Ju. 88 then burst into flames and it side-slipped out of view.

This plate was produced in stages. Stage 1 was of the Ju. 88 flying along over clouds, which again were produced with the aid of CO_2. At a suitable time a detonator concealed in the port engine was fired by remote control. This gave us the initial explosion and subsequent fire. As this model was fully motorised and carried correctly pitched propellors, we found that no external influence was necessary to give the flames the correct amount of "flutter."

We now had to add the ten lines of tracer bullets all converging on the port engine.

Fig. 5. View of Radar Tower Set-up.

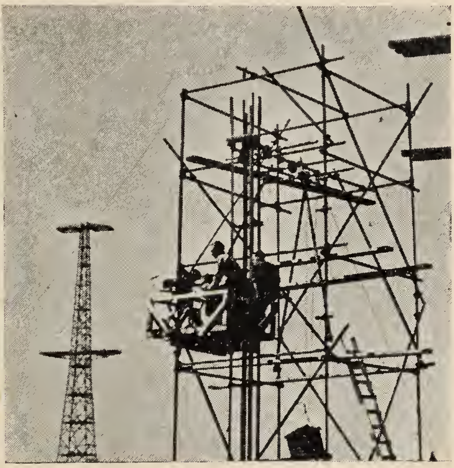

Fig. 6. The Camera Hoist used to film Radar Towers.

Tracer and Smoke-puff

The section of the shot that has so far been described was now developed and printed, and at the point where the tracer bullets were wanted to hit (that is just before the detonator was fired) a frame was punched out of the positive and a pin-hole carefully made through the port engine nacelle. This punched frame was fitted into the camera gate. The camera was set up on a rostrum pointing downwards. Some 40 or 50 feet away a point was marked near the studio floor that exactly coincided with the pinhole in the punched frame. Behind the camera and slightly below the lens—to maintain the correct relative viewpoint—a length of 4 in. × 2 in. timber about 12 feet long was fixed in a horizontal position. On this batten were marked the relative positions of the ten machine guns with which the Beaufighter was fitted. From each of these positions in turn a thin piano wire was run down to the marked point near the studio floor. Down these wires was then run a series of small trollies, each carrying a $4\frac{1}{2}$-volt flashlamp bulb. Then with the stage in complete darkness these were photographed at a camera speed of about 6 or 7 frames per second. After each run the camera was rewound and the running wire moved over to the next position. Thus the ten tracer lines were built up.

The next essential detail of realism that was required was the puff of smoke from the engine immediately preceding the flames. This puff of smoke, it will be noted, is in fact left behind by the Ju. 88 which is travelling forward, and as our Beaufighter from which we are shooting is following on its tail, this puff of smoke will rush towards us and momentarily black out our picture as it flashes past us. To produce this part of the shot a large white flat was placed in a horizontal position with the camera shooting straight down on to it. With the same punched frame in the camera gate a small hole was made in this flat to coincide with the pinhole previously mentioned. The flat was illuminated to a sufficiently high level to give us a maximum negative density. A smoke bomb was then fired through the hole in the flat and the back smoke was guided upwards by baffles towards the camera, which was run at about 8 pictures per second.

These three negatives—the plane, the tracer bullets, and the puff of smoke—were combined in the optical printer, providing the B.P. plate for projecting in front of the Beaufighter cockpit.

Counting the final exposure when actually shooting the B.P. set-up, this shot necessitated 13 exposures in the camera alone.

Bombing Berlin

Finally, to show you how the use of special photographic effects can heighten the dramatic intensity of a film I would like to show you an extract from the R.A.F. film, " Journey Together." The sequence that I am going to show you is of a large bomber raid on Berlin as seen from one particular Lancaster aircraft taking part. During the raid this aircraft is attacked by a night fighter. The Lancaster is hit and crashes in the sea on its way home to base. It sinks and the crew just manage to get away in their dinghy as it sinks.

This sequence was done entirely in the studio, but, unfortunately, time does not permit me to go into all the details of production. However, I shall be only too pleased to answer any relevant questions after the showing.

The paper was illustrated by the projection of sequences from the films " School for Secrets " and " Journey Together."

DISCUSSION

Mr. FRANKS : For the ground shots of Berlin, with the bombs exploding, were library shots used ?

THE AUTHOR : Yes ; they were actually shot by the Operational Section of the R.A.F. Film Unit. We used them as B.P. plates. The Lancaster sequences were shot on the stage, on a real Lancaster fuselage.

Flt.-Lieut. MILLER : Were the dinghy shots done in the studio ?

THE AUTHOR : Yes ; that was all done in the studio tank at Pinewood. The tank measured some 60 ft. square, and in the middle was about 13 ft. deep. A production trick we used to add to the effect of realism was not to use a static camera. The aircraft was a real fuselage, and was sitting on the bottom of the tank. The way we made it appear to heave was by moving the sky backing and the camera, which were both mounted on rafts floating on the water. On the screen I think you will agree it looks as though the aircraft was going up and down.

Mr. CULL : If the fuselage was on the bottom of the tank, how did you get it to tip up ?

THE AUTHOR : The final shot is a model shot, used as a B.P. plate. A model was used, measuring about 6 ft. wing span ; it was sunk in the tank and shot on a high-speed camera. Two things you cannot control are smoke and water ; you invariably have to shoot them at high speed, and this was shot at 148 frames per second. The splash was intensified by the use of compressed air lines, which produced the white foam.

Mr. R. H. CRICKS : Does Mr. Waxman work to any fixed ratio for camera speed in relation to the scale of the model? Mathe-

matics would suggest that the ratio should be the square root of the scale.

THE AUTHOR : We have never started off with any fixed ratio, because I believe there can be no relationship between the two, as camera speed depends upon the action and the ease with which the models, etc., can be manipulated. For example, the model Lancaster aircraft used in the " Journey Together " sequence you have just seen was exactly the same in every case. Yet the flying shots were photographed at 48 pictures per second, and the sinking shot at 148 pictures per second. This was because, as I have already explained, we had water to contend with, and water, like smoke and flames, cannot be slowed down in miniature so you have to run the camera speed up to meet it.

A VISITOR : Would the use of colour allow a similar perfection in model work ?

THE AUTHOR : Yes ; I can see no great problem in using colour. A problem in shooting colour model shots is in getting a camera to run at high speed. Technicolor, I believe, have experimented with a high-speed three-colour camera, but colour shots are more satisfactorily and easily done using Monopak and standard high-speed camera equipment.

A VISITOR : In a model shot is there any effective means of reducing the size of water drops ?

THE AUTHOR : No ; that is a problem, because it is almost impossible to get miniature spray, as the individual drops of water are quite normal and consequently are out of all proportion to the model. In the crashing Lancaster sequence there is a short shot of the aircraft skimming along the water like a speedboat. We first tried to achieve this by actually racing the model through the water with the camera lashed to it by mechanical means. We had to abandon this method because the spray created was completely out of scale to the model. The way we finally did that shot was with a static camera and a static model and the water and spray were blown past it by ten high pressure air lines working at about 40 lbs. per square inch, thus atomising the water.

MR. T. S. LYNDON-HAYNES : With the shot of the tracer entering the fuselage which unlike the one in the Ju. 88 was a lateral shot, was the same method employed ?

THE AUTHOR : No ; that was almost the real thing. We set the camera up inside the fuselage, and we had a machine gun 12ft. away, firing real tracer bullets. An interesting point about that Lancaster sequence is that there is not more than one static shot in the whole of the sequence. The aircraft fuselage, which weighed about 5 tons, was mounted on an elaborate and carefully planned pivot arrangement, so that the whole thing could tilt both ways, and the camera, even when it was almost inside it, was always mounted quite independently of the fuselage. For other shots, where the camera had to be mounted inside the fuselage, we used a free bowl head mounting. One shot was actually done as a tracking shot inside the aircraft, a tiny dolly being mounted on rails along the inside of the fuselage.

A VISITOR : Can Mr. Waxman tell us whether experiments have been made to get rid of the hot-spot on the B.P. screen ?

THE AUTHOR : Unfortunately, you are conscious of the hot-spot in one or two shots but this is not due to lack of experiment, as one always endeavours to eliminate this trouble, invariably with considerable success. The fault in this case is due to the fact that we were forced by lack of studio space to use a 35 mm. lens in shooting the plate, which emphasises the falling off in the corners. One should never shoot a B.P. plate with anything less than a 50 mm. lens.

MR. A. CRITOPH : How did the aircraft go down with the engine alight ?

THE AUTHOR : That was very simply done. The basic shot of the burning city below was a real shot, taken over a German city. All we had to do was to put in something going down. We put a long curved rail in the studio along the path where we wanted the German aircraft to fall ; a piece of wood was soaked in petrol, set alight, and whilst running down the curved rail was photographed in a completely dark studio. Then the shot was double printed.

COLOUR TEMPERATURE CONVERSION FILTER

A new type of filter glass provides a precise means of increasing apparent colour temperature. Colour difference between a light source so modified and a Planckian radiator at the higher colour temperature can hardly be distinguished, even by an experienced observer ; for example, a piece 1.6 mm. thick will convert a source at 2250° K. to 2870° K.

Type OB9 is supplied in unpolished rolled sheet form and to a guaranteed μ coefficient. The usual thickness is 5–6 mm.

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PHYSICAL SOCIETY'S EXHIBITION

THE participation of the Society in the annual exhibition of the Physical Society, held at the Imperial College of Science, Kensington, from April 9th to 12th, took the form of the hourly projection of a reel of 16 mm. film, made up of sequences from a number of scientific subjects, and the display of the various specialised apparatus used for producing these films. The projector was stopped between the separate sections, and a descriptive commentary was delivered by means of a gramophone record.

The sections of film shown comprised the following subjects :

1. *Investigation into the Accommodation of the Human Eye* (by courtesy of Messrs. R. B. Morris and H. E. B. Grimshaw, Kodak Research Laboratories). The behaviour of the pupil after a bright light has been switched off is photographed in visual darkness by means of infra-red radiation and infra-red sensitive film.

2. *Slow-motion photography of Discharge from Fuel Jet* (by courtesy of Mr. W. Buckstone, Kodak, Ltd.) A camera was belt-driven from the fuel pump shaft with a ratio between pulleys of 30 : 31; the picture is a combination of parts of thirty successive cycles, which synthesise into one complete cycle, producing stroboscopically an apparent 30-times reduction of speed.

3. *Slow-motion Picture of Carbon Arcs* (by courtesy of Dr. F. S. Hawkins, G.E.C. Research Laboratories). The film shows an A.C. high-intensity arc, and the striking of a 150-amp. double-negative D.C. studio arc, both slowed down about 200 times.

4. *Surgical Operation under the Microscope* (by courtesy of Mr. T. E. Cawthorne and Mr. E. Gwynne-Evans, the apparatus made by Mr. E. Mackie). The film shows the set-up for filming the operation of the removal of the Eustachian canal, and sections of the film ; the surgeon is seen operating with the aid of a microscope.

5. *Accelerated Motion of a Biological Preparation* (by courtesy of Mr. R. McVitie Weston). The film, taken through the microscope with the aid of time-lapse equipment, shows the white cells of the blood moving through masses of stationary red cells.

6. *Kine-radiograph of Human Joints* (by courtesy of Dr. A. E. Barclay, Nuffield Institute for Medical Research). The film shows the recording of X-ray images of moving joints.

7. *Super-slow-motion of a Splash* (by courtesy of Messrs. G. A. Jones and J. Hadland, Kodak Research Laboratories). The formation of a series of splashes produced by drops falling into a liquid is shown at about 200 times slower than normal.

8. *Diagrammatic Instructional Films* (by courtesy of Mr. Max J. Kaufmann, Dance-Kaufmann Cycle Films, Ltd.). Moving diagrams of the action of a D.C. generator, a Cyclotron, the reflection of a radial wave, and a conductor cutting a magnetic field, are intended to be used as endless loops.

9. *Films in Aircraft Research* (by courtesy of Mr. D. S. Bancroft, Miles Aircraft, Ltd.). The film illustrates the study of the take-off of aircraft by means of two cameras, the behaviour of the aircraft being computed by triangulation.

In all cases except Nos. 2, 3, and 6 the apparatus used for the production of the films was exhibited. In addition, three other pieces of equipment were displayed : a device, shown by courtesy of Miles Aircraft, Ltd., for making photographic records of the instruments of aircraft undergoing test ; apparatus for the recording of traces on a cathode-ray oscillograph ; and a kine-broncho-scope, consisting of a 16 mm. camera attached to a bronchoscope.

The arrangements for the exhibition were entrusted to a committee comprising Messrs. W. Buckstone (chairman of the Sub-standard Film Division), George A. Jones (who was responsible for the editing of the film and writing the commentary), and H. S. Hind, who lent a Bell & Howell projector for the period of the exhibition. Duplicates of the original films were made by Messrs. Kodak, Ltd. The commentary was spoken by Mr. Frank Phillips, B.B.C. announcer, and recorded by Mr. Norman Leevers.

TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library.

A COLOUR PROCESS WHICH MAY RIVAL TECHNICOLOR.

R. H. Cricks, *Kine. Weekly*, December 19th, 1946, p. 272.

A survey of the Agfacolor process is followed by consideration of its problems. A close degree of control is required in processing ; the negative has to be colour-graded before printing, and no fewer than 30 filters of each of the three primary colours, and 30 neutral-density filters, are required in printing. Positive processing is complicated by the requirement of a silver sound track. A satisfactory duping process has not yet been perfected.

AUTHOR'S ABSTRACT.

AGFACOLOR AND ITS FUTURE IN THIS COUNTRY.

T. H. Williamson, *The Cinema*, January 1st, 1947, p. 461.

While all stock manufacturers have investigated the Agfacolor process for the professional market, no material is yet available. The possibility of economising in processing by the use of a dye sound-track is suggested, which would necessitate the use in the kinema of antimony-caesium photo-cells.

R. H. C.

BRITISH TRICOLOUR PROCESS.

R. H. Cricks, *Kine. Weekly*, April 3rd, 1947, p. xix.

Subjects are photographed either on three separation negatives (a special bipack-and-one camera having been built for the purpose) or on a single negative with consecutive frames exposed through different colour filters and run at 72 frames per second. A stripping process is also described. The printing method envisaged consists in printing the blue record negative upon a positive emulsion containing a yellow former, re-coating with an emulsion containing a magenta former and exposing through the green record, and again re-coating with an emulsion containing a cyan former which is printed from the red record ; all three layers are colour-developed simultaneously. The positive method at present in use differs from this in that each layer is processed before the next is applied. The films projected are described as of high quality.

AUTHOR'S ABSTRACT.

PIONEER RECORDING CHANNEL.

R. H. Cricks, *Kine. Weekly*, April 3rd, 1947, p. xx

A complete recording channel produced by Pioneer Films comprises a Capco camera mounted on a self-contained console, disc recorder, mixer console, and amplifying unit. An experimental development is recording by means of a cathode-ray tube.

AUTHOR'S ABSTRACT.

MAGNETIC SOUND RECORDING.

J. Soc. Mot. Pic. Eng., January, 1947.

The first article, by S. J. Begun, of the Brush Development Company, mentions Poulsen as the originator, in 1898, of magnetic sound recording ; as early as 1917 suggestions were made to use magnetic sound recordings in conjunction with a complementary picture film. The Brush Company in 1939 brought out a magnetic paper tape recorder, the paper tape being coated with a magnetic powder. It is stated that with a tape speed of 7.5 in. per second a response up to about 5,000 c.p.s. can be obtained, with a signal to noise ratio better than 60 db. It is suggested that a 35 mm. perforated magnetic tape could be introduced into standard recording practice. War time developments by the Brush Company include the development of a ductile non-magnetic, non-ferrous wire, which is plated with a thin layer of a highly magnetic nickel-cobalt alloy.

The second article, by Marvin Cameras of the Armour Research Foundation, deals with magnetic sound for motion pictures. The advantages and disadvantages of optical recording *versus* magnetic recording are enumerated and experiments are described in which acetate or nitrate film stock was used, coated to a thickness of half-mil with a magnetic material. Push-pull and stereophonic records are also possible by using two tracks at the same time.

Further experiments are mentioned of coating 35 mm., 16 mm. and 8 mm. picture films with a magnetic material. On the 35 mm. film, instead of using the usual photographic sound track, a 100 mil magnetic coating is provided. Similar suggestions are made for 16 mm. film (80 mil coating on the non-perforated side of the film). Synchronisation of the sound record with the picture record is made by driving the sound recording and picture cameras with synchronous motors which, when up to speed, operate relays which put a scratch or dab of paint on each film, thus providing synchronising marks.

The frequency response of magnetic sound records thus obtained is mentioned as being lat from 50 to 12,000 c.p.s. within ± 3 db.

The third article, by R. J. Tinkham and J. S. Boyers of Magnecord, Inc., concerns a magnetic wire recorder which has an extremely accurate wire feed arrangement and about a mile of wire must pass through the machine before a total slippage of the order of one foot is encountered. The authors suggest the use of a motor of the interlock type for employing the apparatus in conjunction with film work. The speed of the wire is 4 feet per second and the best wire to use has been found to be of stainless steel having a diameter of 0.004 in.

The frequency range claimed is from 10 c.p.s. to 30,000 c.p.s. in the recording, whilst the playback head gives a rising frequency response of 6 db per octave from a low frequency to approximately 1,000 c.p.s. The high end of the frequency range begins to fall off at approximately 5,000 c.p.s. and at 12,000 c.p.s. it is about 15 db down from the level at 1,000 c.p.s.

The fourth article, by H. A. Howell, of the Indiana Steel Products Co., describes the use of coated paper tape for magnetic sound recording and, contrary to the Germans, who have been using red Magnetite (gamma phase Fe_2O_3) exclusively, the article describes investigations concerning other coating materials, especially a magnetic powder known as " Hyflux " with which, with a tape speed of 8 inches per second, a good frequency response up to about 6,000 c.p.s. has been obtained. A special paper for use as a base has been found having advantages over plastic ribbons, especially as it can be easily handled, edited and repaired whilst the paper can be perforated in the same way as any ordinary 35 mm. film. O.K.K.

SCREEN ILLUMINATION WITH CARBON ARC MOTION PICTURE PROJECTION SYSTEMS.

R. J. Zavesky, C. J. Gertiser, W. W. Lozier, *J. Soc. Mot. Pic. Eng.*, 1947–48, 73.

The screen illuminations given by low intensity and high intensity arc projection systems are tabulated. Typical figures for screen lumens range from 2,500 lumens given by low intensity at 32 ampères to 21,500 lumens given by a 13.6 mm. rotated high intensity positive at 170 ampères. These values are for projectors with no film in the gate, no shutter running, no porthole glass and no heat filter.

The central screen illuminations in ft. candles, assuming a shutter transmission of 50% and a porthole glass of 90% transmission, but with no heat filter or film in the machine, are plotted against screen width. They are also recalculated as screen brightnesses for a screen having a 75% reflection factor, and it is shown that by choice of a suitable projection system, screens of 10–39 ft. width can be illuminated to the level of brightness of $10 \pm ^4_1$ foot-lamberts recommended by the American Standards Association. F. S. H.

IS THE PROSCENIUM NECESSARY IN MODERN KINEMAS?

R. H. Cricks, *Ideal Kinema*, October, 1946, p. xix.

While the proscenium arch is considered undesirable from the point of view of sound distribution, there are four reasons calling for its retention : as a frame work to the projected picture, as an ornamental feature during intervals, as a means of concealing tabs and drapes, and in connection with stage presentations. Alternative methods of meeting these requirements are considered. AUTHOR'S ABSTRACT.

MALTESE CROSS WITH COMPENSATED ACCELERATION.

La Cinématographie Française, October 5, 1946, p. xx.

A description of the intermittent motion device of the Radion projector shows it to comprise an orthodox Maltese cross system, but with the cam driven by means of a slipper-block on the eccentrically disposed flywheel shaft, and so accelerated during the shift period of the cross. The acceleration is at its maximum at the point where the striker pin leaves the cross slot. A 50 per cent. increase in screen illumination is claimed. R.H.C.

COLOUR TELEVISION CONTROVERSY.

RCA Review, Vol. VII, No. 4, December, 1946 ; *Electronic Industries*, December, 1946 ; *Broadcasting*, December 23rd, 1946, p. 17 ; D. G. Fink, *Electronics*, January, 1947.

During the F.C.C. hearing of the C.B.S. petition for the initiation of colour television transmissions, the RCA have launched an alternative system. This uses simultaneous as against the C.B.S. sequential scanning of the primary colours. The main advantage claimed, is that existing monochrome receivers can continue to be used. By means of a simple tuning " converter " they would receive the " green channel " only as a monochrome picture. To receive a colour picture it is necessary to superpose and accurately register the three primary pictures, which limits the system to the use of three projection tubes and associated lenses. A very complicated triple-gun cathode ray tube has been proposed—but not yet apparently made—by Du Mont. The pros and cons of the RCA and C.B.S. claims are discussed in detail in the last of the above references. L. C. J.

BOOK REVIEWS

HISTORIQUE ET DEVELOPPEMENT DE LA TECHNIQUE CINEMATOGRAPHIQUE, by Jean Vivié. Editions B.P.I., 79, Av. des Champs-Elysées. Paris, 8e. 137+XXXIII *pp.,* 680 *fr.*

The present work is the first of a series of 12 volumes covering all technical aspects of kinematography. Their author is head of the School of Kinematography in Paris, and it is to be expected therefore that they should be in the nature of text-books. The present volume is in fact more than a history—it is an introduction to the whole of the science of kinematography.

In discussing the origins of kinematography the author distinguishes between animated projection, and " chronophotography." The first with some justification he credits to Emile Reynaud, whose " optical theatre " (a Praxinoscope embodying an endless band of perforated film) was based upon a patent of 1888. Under the second heading, credit is very fairly assigned to many inventors, notably Marey, Edison, and the Lumière brothers, the sole fault—to English eyes—being the scanty credit paid to William Friese-Greene : is our faith in the priority of the British inventor merely an illusion carefully fostered by the film trade historian, the late Will Day ?

At a later stage, too, Vivié's views of the British industry are not complimentary : " L'industrie cinématographique anglaise ne se développa guère ; à côté de l'agence créée par la Société L. Gaumont en 1908 . . . . on ne peut guère citer que le nom de l'inventeur et industriel Vinten, fabricant de caméras, projecteurs, et matériel de laboratoire." The late W. Vinten did not as a matter of fact commence his own business until 1911 ; a number of still existing firms were manufacturing on quite a large scale long before that time.

Having very briefly continued the story of the trade up to 1914, the author turns to sound and colour, both of which subjects are dealt with far too cursorily. In three pages the history of the cartoon film is covered, from Reynaud to Disney. Trick work—the scientific film—the sub-standard film—all receive too brief mention.

A valuable feature of the book is the several chronological tables, and the lists of patents. The volume concludes with 32 pages of interesting historical illustrations.

Jean Vivié's book may be regarded as the most authoritative work yet published on the technical development of kinematography. If equally comprehensive researches were undertaken in this country and in America (much of the material is indicated by Vivié) and the results of the three combined, we should have virtually the complete and authentic history of the birth of our industry.

R. H. Cricks.

TELEVISION RECEIVING EQUIPMENT, by W. T. Cocking, M.I.E.E.

This little book should fill the need for a compact source of information on television receiving apparatus. It is not intended for the pure beginner, but is written to give an extension of knowledge to radio engineers into the realm of cathode ray tube scanning circuits and wide band receivers and the other features peculiar to the application.

To those who are not in the radio industry it may be mentioned that W. T. Cocking is the Editor of the *Wireless Engineer* and has for many years contributed extremely practical articles to the *Wireless World*, both on radio and television, and the present book is based in general on a selection of the contributions which he made to cover television subjects.

The introduction to the principles of television is very short and the book gets directly to its subject in a manner completely free from side issues. Under the different chapter headings are given various variations of the special circuits required for television receiving purposes, and the book includes information and circuit diagrams together with half-tone blocks. Most of the diagrams include values of all components to enable the reader to construct those he is interested in.

To cover the construction of a television receiver Mr. Cocking has also included in the book the circuits of a superheterodyne receiver with an alternative straight vision receiver which can be used within 10 miles of Alexandra Palace and a double deflecting magnetic time-base and power supply unit suitable for commercial cathode ray tubes. The instructions are such that the reader having followed the circuits and the information given should then be able to adjust and line up a set so as to receive pictures of good resolution and general satisfaction.

The book ends with two chapters on faults and their remedies and television servicing, which, although short, is very much to the point. The diagrams are all drawn with admirable clarity and in all

cases actual values of components are stated.

While being a useful reference book, keeping closely to its subject, it could act as a very useful guide to the home constructor anxious to receive the high quality programmes once more available from Alexandra Palace. T. M. C. LANCE.

ELECTROPHYSIOLOGICAL ANALYSIS OF COLOUR RECEPTION

THE various solutions of the problem of colour photography are based upon the facts of colour mixture, which can be analysed and applied wholly without the need for any hypothesis as to the nature and functioning of the visual receptor apparatus, so that strictly speaking, the study of the physiological aspects of the phenomena of colour vision is altogether outside the region with which photography is concerned. Nevertheless, familiarity with the literature of colour photography inevitably arouses interest in the classical theories of colour vision.

Nearly one hundred and fifty years ago (in 1801) that astonishingly versatile Somerset physician, Dr. Thomas Young, F.R.S., who has been called the founder of physiological optics, propounded the hypothesis that colour perception depends on the presence in the retina of three kinds of nerve fibres, which respond respectively to red, green and violet light. Since Young, innumerable workers have accumulated indirect evidence to support his hypothesis, but experimental proof of the existence of the hypothetical receptors has only recently been obtained by Professor Ragnar Granit, Director of the Nobel Institute of Neurophysiology, The Royal Caroline Institute, Stockholm.

In the fourteenth Thomas Young Oration, delivered on 29th June, 1945, before the Physical Society, Granit described the extremely beautiful investigation which has so completely endorsed the soundness of Young's scientific imagination.

Granit's methods are based on the work of the eminent British physiologist, Professor Adrian, who first demonstrated that all sense organs respond to stimulation by discharging electrical impulses through their associated nerve fibres, variations in stimulus intensity producing variations in frequency of an impulse of constant size in an individual nerve fibre. Granit developed a special micro-electrode technique for isolation of individual fibres (a task of immense difficulty) the electrical responses to the stimulus being amplified and led to a loudspeaker. Measurements were made of the absolute threshold to spectral light of various wave lengths throughout the spectrum. It was found that cone receptors in the retina of the snake, cat, guinea-pig, frog, etc., possess spectral sensitivities grouped in three main bands 600—580 $m\mu$, 540—520 $m\mu$, and 470—450 $m\mu$. The sensitivity curve of a single receptor is usually narrow with a maximum in one of these three regions. The reason why receptors respond selectively to radiant energy is unknown. Probably no two receptors respond to identical wave-length ranges, but sensitivity is in the main confined to three regions. Why the message of one receptor should ultimately be projected in consciousness as redness and of another as greenness remains utterly mysterious. Granit has been unable to discriminate between the signals from different receptors, though there may be differences too fine to be detected by his present apparatus, but presumably the current in either case is connected to a different type of responder at the cortical end of the circuit.

The three main classes of receptor Granit calls " modulators " and a unit having a much broader wavelength sensitivity band which he calls a " dominator " he believes is a composite receptor composed of individual modulators of the three types. The wider response curves of the classical trichromatic theory are assumed to represent average curves for the large number of red, green, and blue modulators in the most sensitive part of the retina, *viz.*, the foveal area.

Wright's curves for the red sensation in the central fovea had suggested its probable composite nature and Granit's proof of the existence of a yellow modulator with a maximum at 580$m\mu$ has enabled him to construct a combined curve (red modulator plus yellow modulator) which closely corresponds with the earlier curve.

Thus Granit has provided at last objective evidence in support of the actual existence of a visual trichromatic mechanism and thus substantiated the past speculations of physicists, physiologists and psychologists. This is an immensely important achievement.

A. CORNWELL-CLYNE

GRANIT, RAGNAR.—*The Electrophysiological Analysis of the Fundamental Problem of Colour Reception.* Pro. Physical Society, Vol. LVII, p. 447, 1945.

THE COUNCIL

Meeting of March 5th, 1947

Present : Messrs. I. D. Wratten (*President*), Rex B. Hartley, L. Knopp, S. B. Swingler, A. W. Watkins, A. G. D. West (*Past President*), C. H. Bell (*representing Theatre Division*), W. Buckstone (*representing Sub-standard Division*), B. Honri (*representing Film Production Division*), and R. H. Cricks (*Secretary*).

Election of Council.—The Officers of the Society placed their resignations in the hands of the Council, but were unanimously asked to continue in office. It was noted that Messrs. Champion and Swingler were due to retire ; the position of Mr. A. G. D. West was dependent upon the re-election of Mr. Wratten to the Presidency. The Divisional representatives also retired.

Divisional Committees.—The composition of Divisional Committees was agreed as follows :

	Chairman	Appointed by Executive until 1948	Appointed by Council until 1949	Elected until 1948	To retire
THEATRE DIVISION	S. B. Swingler	C. H. Champion R. Pulman H. C. Stringer	W. F. Garling S. T. Perry J. L. Stableford	C. H. Bell L. Knopp A. Newing	R. J. Engler F. H. Sheridan-Shaw S. A. Stevens
SUB-STANDARD DIVISION	H. S. Hind	C. Cabirol N. Leevers	W. Buckstone S. Schofield	D. F. Cantlay D. Ward	H. E. Dance (G. H. Sewell previously resigned)
FILM PRODUCTION DIVISION	A. W. Watkins	C. E. Crowhurst W. M. Harcourt Rex B. Hartley	F. G. Gunn H. Harris T. Howard (L. Thornburn offers his resignation)	B. Honri T. S. Lyndon-Haynes (E. Williams' resignation conveyed by Mr. Hartley)	G. Blattner F. J. Cox J. J. Croydon H. Huth

Attendance at Committees.—The President was authorised to appoint a deputy for any member of a committee leaving London for any length of time.

Papers Committee.—Preliminary proposals for the 1947/8 lecture programme were considered.

A.C.T. Meetings.—It was agreed that if further joint meetings were held with the A.C.T., their arrangement should be in the hands of the Film Production Division.

Training of Projectionists.—It was reported that the C.E.A. and N.A.T.K.E. had agreed that the Society should be the educational authority responsible for the examination and certification of projectionists.

Adoption of Metric System.—Correspondence with the B.S.I. and the Decimal Association was reported, relative to the recommendation of the Foreign Relations Committee that the adoption of the metric system be furthered.

Theatre Division.—It was reported that the Theatre Division Committee had not accepted the recommendation of the Council that an Hon. Secretary be appointed.

Film Mutilation.—It was reported that, in accordance with the recommendations of the Film Mutilation Committee, the C.E.A. proposed inviting the Society to prepare a booklet on the care of film, for circulation to projectionists, and that the K.R.S. had appointed a Committee of Print Managers.

Meeting of April 2nd, 1947

Election of Council.—Tentative list of nominations was submitted. Mr. A. W. Watkins had been nominated as Vice-President, but did not wish to stand for election.

Qualifications for Membership.—Draft modification to By-law 3, relating to qualifications for Membership, was provisionally approved.

Constitution of Branches.—Following consideration of a draft constitution for Branches of the Society, decisions were deferred until a subsequent meeting.

Journal.—Alternative designs for a new cover for the *Journal* were considered, and a decision taken to adopt one of the designs. Change of title to *British Kinematography* was agreed.

It was reported that publication of the March/April issue had been delayed by lack of blocks.

Papers Committee.—It was reported that the A.C.T. was anxious to arrange further joint meetings, and was agreeable to these being held with the Film Production Division.

Education Committee.—Minutes of a meeting of the Education Committee were submitted, from which it appeared that the Committee was anxious regarding the position of the Society in regard to the proposed British Film Industry Joint Training and Apprenticeship Council.

Library.—It was agreed that the Divisions should be asked to appoint Library representatives, each to attend the library one evening a month.

Brussels Film Festival.—Mr. Baynham Honri was appointed to represent the Society on a C.O.I. committee to select short films for inclusion in the Brussels Film Festival.

EXECUTIVE COMMITTEE

Meeting of March 5th, 1947

Present : Messrs. I. D. Wratten (*President*), R. H. Cricks (*Secretary*), Miss Barlow (*Assistant Secretary*).

Elections.—The following were elected :

Ernest William Stimson (Member), Kay West End Laboratories, Ltd.
Roy Nelson Jones (Student), Regent Street Polytechnic.
Adrian Henry Cooper (Student), Regent Street Polytechnic.
Roy Frank George Scott (Member), G.B.-Kalee, Ltd.
Leslie Ronald Long (Associate), G.B.-Kalee, Ltd.
Frederick Wells Corden (Associate), Denham Laboratories, Ltd.
Eric Sydney Morden (Associate), Sound-Services, Ltd.
William Thomas George Bush (Associate), George Humphries & Co., Ltd.
Louis H. Lavelly (Member), G.-B. Instructional.
Albert James Betts (Associate), Odeon Theatre, Redhill.
Cecil A. Hill (Associate), Mobile Film Co.
Leonard Lawrence Ellis (Associate), Leonard Ellis (Sub-Standard) Films, Ltd.
Stanley George Gale (Student), G.F.D., Ltd.
Leslie Maskell (Member), Pathé B.I.F.
Albert Claude Batchelor (Member), D. & P. Studios, Ltd.

Meeting of April 2nd, 1947

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), E. Oram (*Hon. Secretary*), P. H. Bastie (*Hon. Treasurer*), R. H. Cricks (*Secretary*), Miss S. M. Barlow (*Assistant Secretary*).

Elections.—The following were elected :

Eric Blake (Associate), Bradford Civic Playhouse.
Frederick Humphrey Green (Associate), RCA Photophone, Ltd.
Bernard Thomas Druce (Member), Leevers, Rich & Co.
Arthur Challinor (Associate), G.B.-Kalee, Ltd.
William Charles Greatbatch (Associate), Denham Laboratories, Ltd.
George Vernon Summersgill (Associate), Palace Cinema, Droylsden, Manchester.
John Charles Jordan (Associate), G.B.-Kalee, Ltd.
Lewis Stanley Ray (Associate), Alliance Films, Ltd.
Miss Marjorie Owens (Associate), Southall Studios.
Edwin Francis Bradley (Member), Metro-Goldwyn-Mayer Pictures, Ltd.
John Alan Guy Dacombe (Student), Southall Film Studios.
Dr. S. B. Seth (Associate), Amalgamated Dental Co., Ltd.
William Charles Grant (Associate), Geo. Humphries & Co., Ltd.
Thomas O'Sullivan (Associate), National Studios.
Cyril Arthur George Cambridge (Associate), M.G.M. Pictures, Ltd.

Transfers.—The following Associate was transferred to Membership :

Charles Patrick Sunderland, British Movietonews, Ltd.

Staff.—An increase of staff was reported.

ELECTION OF COUNCIL

The first Ordinary Meeting of the newly constituted British Kinematograph Society was held on May 14th, 1947, at the Gaumont-British Small Theatre, Wardour Street, W.1. The President, Mr. I. D. Wratten, was in the Chair.

A report of the past year's work was read by the Hon. Secretary, Mr. E. Oram, and the accounts were presented by the Hon. Treasurer, Mr. P. H. Bastie.

The scrutineers in the election of two Members of Council announced that Mr. Charles H. Champion and Mr. Baynham Honri had been elected. (Mr. B. Honri represents the Film Production Division in addition to being an ordinary Member of Council.) The officers were unopposed.

The meeting will be more fully reported in the next issue.

DIVISIONAL COMMITTEES

The following have been elected to the Committee of the Theatre Division : Messrs. F. H. Sheridan-Shaw, S. A. Stevens and J. A. Walters.

Four members have been elected to the Committee of the Film Production Division : Messrs. F. Young, F. J. Cox, H. Waxman and G. Burgess.

Messrs. H. E. Dance and G. H. Sewell have been re-elected to the Sub-standard Division Committee. During Mr. Sewell's absence in East Africa, Mr. F. V. Heath has been nominated by the President as his deputy.

THE LIBRARY

Very generous response has come from the few to my appeals for books for the Library. But too few have responded, and I therefore make this appeal to each of you to support the Library by the contribution of a book.

The Library is made up of the following :

1. History
2. Reference
3. Technical
4. Associated Sciences
5. Cultural

A list of titles which it is desired to procure has been compiled, and may be obtained on request. I would greatly appreciate every assistance from those who would donate books.

Space on our bookshelves has been placed at the disposal of the Television Society to house their library temporarily where members can use it for reference. It must be understood these books cannot be borrowed.

The hours of the library are as follows : Daily, 9.30 a.m. to 5.30 p.m. ; Mondays, 9.30 a.m. to 8 p.m. ; closed Saturdays.

Readers are entitled to borrow two books for a duration of fourteen days. Postal borrowing is not yet possible.

Periodicals, not only of England but other countries, are received regularly and are in the Library for reference. Suggestions from members will be welcomed ; our object is to create a Library fitting with the aims of the Society.

REX B. HARTLEY,
Chairman, Library Committee.

PERSONAL NEWS OF MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of the Journal.

A. P. CASTELLAIN is recovering from a severe operation.

C. H. CHAMPION is also making a good recovery from a major operation.

JOHN CROYDON has been appointed by J. Arthur Rank to be in charge of Highbury Studios, where second-feature films are to be produced.

J. HADLAND has joined the Kodak research staff.

J. C. JORDAN has been appointed in charge of the purchasing department of the new M.G.M. Studios, Elstree.

T. S. LYNDON-HAYNES is now production manager at Southall Studios.

MATT RAYMOND has rejoined M.G.M. in the 16 mm. department.

A. H. ROSS, founder of the Film Department of S. H. Benson, Ltd., has resigned to undertake factual and visual research, both home and overseas ; he will work in conjunction with the Film Producers' Guild, Ltd.

R. H. A. STANIFORTH is making a 16 mm. record of the foundation year of his teachers' training college : he has been elected a member of the Council for Visual Education.

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(Three issues only)

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BRITISH KINEMATOGRAPHY

The Journal of the British Kinematograph Society

VOLUME ELEVEN, No. 1. JULY, 1947

Third Arthur S. Newman Memorial Lecture.

BRITISH INFLUENCE IN THE TECHNICAL DEVELOPMENT OF KINEMATOGRAPHY

R. Howard Cricks, F.B.K.S., F.R.P.S.*

Read by Mr. Baynham Honri to a joint meeting of the Royal Photographic Society and the British Kinematograph Society on December 14th, 1946, and by M. Jean Vivié to the Association Française des Ingénieurs et Techniciens du Cinéma on April 18th, 1947.

THIS paper makes no claim to be an impartial record of the invention and development of the kinematographic industry. It aims merely at a portrayal of the part played in the technical development of the Industry by British technicians, and without any undue patriotic bias it may fairly be said that this part compares favourably with that of any other country.

I. INVENTION

Although our eminent film trade historian, the late Will Day, F.R.P.S., F.R.S.A., has traced the birth of kinematography to drawings dating from 25,000 B.C., portraying the movement of a trotting bear, it would be more reasonable to date its scientific beginnings from researches into persistence of vision.

Analysis of Motion

While Leonardo da Vinci, Newton, and many others had some knowledge of the subject, the first systematic researches seem to have been made by Dr. P. M. Roget, who in a paper before the Royal Society in 1824 described many aspects of the subject and originated what was to become for more than half a century an essential of most attempts to analyse or synthesise movement—the rotating shutter with a narrow slit.

A converging line of discovery was the invention of photography. Of the many attempts made to capture in permanent form the image on the screen of the camera obscura, the names of Tom Wedgewood and Fox Talbot rank pre-eminent.

An outstanding example of the application of photography to the study of motion was the recording by Eadweard Muybridge, an English photographer working in San Francisco, of the movements of a trotting horse. One of the original prints of this historic series of photographs was presented by the B.K.S. to the Science Museum, South Kensington. Muybridge succeeded in

* Technical Editor, *Ideal Kinema.*

projecting his pictures by the classical apparatus of a glass disc revolving behind a high-speed slit shutter.

Optical Compensation

According to our historian above quoted, true kinematography begins with the patent of William Friese-Greene, of 1889. But earlier than this there is a strangely interrupted story of Louis-Aimé-Auguste Leprince, an Alsatian working in London, whose equipment so far as we know never attained any close resemblance to modern equipment ; according to his patent No. 423 of 1888 it employed a battery of 16 lenses and two films, although it has been reported that he produced a single-lens camera. In 1890 Leprince set out on a visit to France and at Lyons descended from the train and was never seen again.

At what stage then can we assert that kinematography was born ? A number of inventors had modified the slit shutter principle by the addition of optical components. Reynaud in France projected films by means of the Praxinoscope, a device employing a mirror drum, in 1888, and in 1894 Jenkins in America patented the lens-drum principle which we have so often seen since. But it would be fair to suggest that kinematography commenced with the use of strip film moved intermittently, with a shutter which cut off the light during the period of movement. The sole reason for fixing this datum line is that it was apparatus of this type that first proved itself capable of commercially successful results, and has with rare exceptions been used ever since.

Patent Priority

On this basis Friese-Greene's patent No. 10,131 of 1889 may, so far as the claiming clauses are concerned, be justly described as the original invention of kinematography, since it claimed apparatus embodying these essentials.

It is not unfair to suggest that Friese-Greene, when he prepared this specification, had little idea of the requirements of kinematography. But that his claims were not, as has been so often asserted, confined to this patent specification is evident from the camera which the author is able to show by courtesy of Mr. S. J. Cox, of Dufay-Chromex (Figs. 3 and 4). It is dated 1890, and provides for two separate wide films with intermittent motions, presumably for the purpose of producing either coloured or stereoscopic films. However, those of use who knew Friese-Greene can well believe the accounts of his contemporaries : that he never produced commercially acceptable apparatus.

Other names have been brought forward to dispute Friese-Greene's priority: Robert W. Paul, Birt Acres, Marey, Demeney, the Lumière Brothers, Skladanowsky, and the ubiquitous Thomas Alva Edison.

British Inventors

Robert W. Paul played a quite important part in the early development of the film. His first apparatus was of course merely a copy of Edison's Kinetoscope, a peep-hole machine employing continuously running film and a slit shutter ; but as a result of his being compelled by the withholding of supplies of Edison films to his customers to develop a camera, he designed both a camera and a projector, both with intermittent motions, and he produced considerable quantities of films. It is probable that for a couple of years he was the largest producer of films in the world, not excluding Edison and Lumière.

Paul has been frequently credited with the invention of the Maltese cross, but there seems no question that this principle was in fact well known in many branches of engineering, and was used in the construction of animated slides,

such as the Choreutoscope. Paul's first projector apparently dispensed with a friction gate, employing intermittently driven sprockets above and below the aperture. Fig. 1 illustrates a machine described in his Patent No. 4686 of 1896.

In 1895 Birt Acres patented a camera employing a crude form of the modern clamping gate with a spring film feed. Although he cannot claim patent priority, he was undoubtedly the originator of certain apparatus, and one of the earliest workers. Birt Acres was also responsible for the first sub-standard camera, having produced a camera using film described as half the standard width.

French Pioneers

Marey was making films of a scientific nature as early as 1887. But his equipment was incapable of producing accurate registration of the picture, and the film could not therefore be projected without being re-registered. Leon Gaumont has recorded that, in conjunction with Deméney, an assistant of

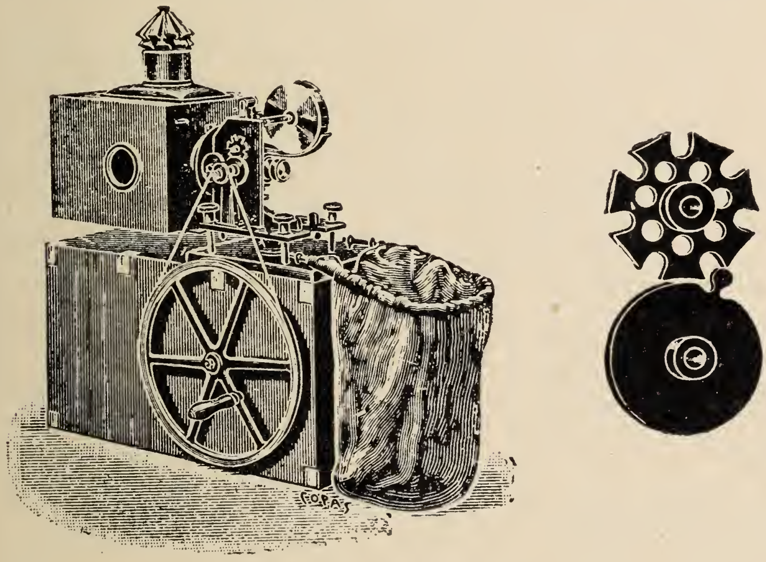


Fig. 1 Robert W. Paul's Projector and Intermittent Motion Device

Marey's, he demonstrated in 1896 a projector embodying an intermittent motion obtained by means of a cam. (Deméney's patent No. 24,457 of 1893 describes a method of obtaining an intermittent motion by mounting the take-up bobbin eccentrically.) This was later replaced by a Maltese cross. Colonel Bromhead states that in 1895 exhibitions were given on a Deméney projector in a hall in Regent Street. A modification of the above-mentioned patent led to the invention of the dog motion.

In the same month that Paul demonstrated his Theatrograph at the Finsbury Technical College, the association of the Polytechnic, Regent Street, with kinematography began with a programme of films presented by Louis Lumière. Patriotic Frenchmen hail the Lumière brothers as the inventors of kinematography ; they undoubtedly played an important part in its early development, notably by the invention of the famous Lumière claw movement, and almost certainly in the manufacture of sensitised stock ; but there is no evidence that they anticipated Deméney. However, the important part

played by the Lumières in popularising the new science must not be underestimated.

Edison's Film Gauge

It is recorded of Edison that his earlier machines employed the classical principle of a continuously running film and slit shutter, and furthermore that he always refused to attempt the manufacture of a projector, holding that a peep-hole device would prove more profitable. On the other hand, to him belongs the credit of originating the present 35 mm. film standard—or should one rather say, to his English assistant, W. Kennedy Dickson ?

The fact is that for half a century men's minds had been working on the problem of kinematography, and it so happened that in the years 1895 and 1896 half-a-dozen inventors hit on substantially the same solution. Arthur Pereira states that Lumière, Skladanowsky, and Jenkins all projected their first films in public within three months of each other, at the end of 1895. Lumière's show was at Lyons, Jenkins's at the World's Fair at Philadelphia, and Skladanowsky's at the Winter Garden, Berlin.

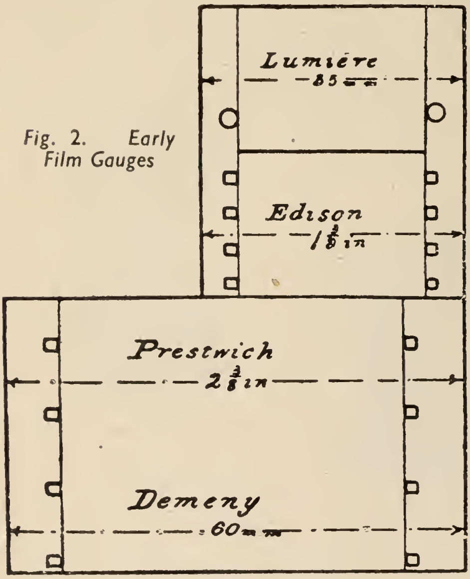


Fig. 2. Early Film Gauges

The Invention of Celluloid

One other vital contribution to the science of kinematography must be mentioned—the invention of celluloid. A number of claimants have arisen. Will Day supported the claims of Alexander Parkes of Birmingham, but claims have been put forward for many other workers. Friese-Greene made his own celluloid in 1889. There seems little doubt that Eastman was the first to market celluloid film for kinematographic purposes, but it has been claimed that it was first produced by the Blair Company (of which the author's father was sales manager). Whether Blair actually preceded Eastman is open to doubt.

British Pioneers

Although he could lay claim to no part in the basic invention of kinematography, it was at a quite early date that a man who has left his mark upon the mechanical development of the industry enters the picture : Arthur S. Newman, the beloved " little man," whose memory we honour to-day. Of even more lasting value was Newman's contribution to the standardisation of films and apparatus, to which reference will be made later.

Only slightly later was Ernest F. Moy, like Paul an electrical engineer who turned his attention to the developing industry. With Percy H. Bastie, to-day Honorary Treasurer of one of our Societies, he developed a type of camera which for many years held the field—the so-called English type of camera with magazines placed one above the other inside the camera-case. In premises which they still occupy to-day, the firm made also projectors, printers, and developing gear, and on their roof made a number of films ; a catalogue of 1898 lists no fewer than 47.

Yet another name that should be mentioned is that of James Williamson,

who with his four sons—still, of course, outstanding in the Industry—represented probably the first "vertically integrated combine", since his activities embraced the manufacture of equipment, film production and processing, and distribution.

II. THE FIRST DECADE

By the end of the century the film was in process of becoming an industry. Already a number of studios were in operation : Cecil Hepworth's at Walton-on-Thames*, Paul's at Southgate, Williamson's and G. A. Smith's at Brighton, Mottershaw's at Sheffield, and others. While we have all heard of Edison's "black Maria," it appears that very shortly after, a similar studio, rotatable to catch the sunlight, was built in the Adelphi.

By the early 1900's there was a number of firms producing films of varying degrees of merit. The foremost was, perhaps, that of Cecil M. Hepworth ; even in those days Will Barker performed prodigies of rush work in the news-reel field besides producing theatrical films ; while Cricks and Sharp (later Cricks and Martin, the Martin being, of course, J. H. Martin now of Merton), and the Clarendon Film Co., of which L. J. Hibbert, now principal of the Polytechnic School of Photography, was a member of the technical staff, were both active.

In 1903 Cecil Hepworth built the first covered studio in the country, lit by arc lamps.

In this period, too, films first acquired titles. The author's father used to claim having originated the master title, the introduction of which met with considerable opposition from his customers, who objected to paying 4d. a foot for something that did not move.

III. MECHANICS

In a general sense, the outstanding development of the mechanical side of the Industry has been the ever more stringent standard of accuracy. Newman's accuracy was the accuracy of the craftsman, not of the measuring machine, and for many years the quality of his work stood pre-eminent. One essential feature of modern studio and optical equipment must be accredited to him—the pilot-pin, without which Technicolor would be impossible and the modern optical printer useless.

But Newman rendered a still greater service to our Industry. He was the first to appreciate the need for standards. It was largely as a result of his persistence that the Kinematograph Manufacturers' Association formed what was probably the first Standards Committee in the history of our Industry. The K.M.A. Standards Committee was the true ancestor of the Cinematograph Industry Division of the British Standards Institution.

Continuous Processing Plant

Cecil Hepworth at his Walton-on-Thames plant early realised the inefficiency of the rack-and-tank system of development. In 1898 he built the first continuous processing machine ; this employed long horizontal tanks, but as we all recall, his engineer, H. V. Lawley, later replaced this principle by the system of long vertical tubes.

In 1912 one of Newman's employees, imbued with Newman's standard of accuracy, left to start his own business. That business to-day is W. Vinten Limited, and there is probably no British firm which has left a greater mark upon the mechanical progress of our Industry.

One of Vinten's first jobs after 1918 was the design and installation of automatic processing plant, again the prototype of apparatus which is to be found throughout the world. His printing machine with its patented method

*The Jubilee of this studio was celebrated on June 27, 1947.

of light-control, is admirably suited to the requirements of British laboratories.

Vinten also followed Newman's example in his keenness for standardisation and co-ordination and, like Newman, was one of the original founders of one of our two Societies.

IV. PRODUCTION TECHNIQUE

There is little doubt that most of the technique used in film production owes its origin to British technicians. As early as 1899 Paul's studio was provided with a camera trolley, and with its aid trucking and zoom shots were made, even though as late as 1912 or 1913 the static camera was generally preferred. D. W. Griffith is commonly credited with the invention of the close-up ; yet in 1898 Paul was featuring this device.

Special Effects

Trick films are as old as the film itself. In 1897 G. A. Smith, later the inventor of Kinemacolor, took out a patent on double-exposure. Most of the early British comedies depended for their humour on the risible effects of stop-action, reversal, slow action, fast action, double-exposure, and so forth.

Model shots were, of course, very popular, and even in the early days the desirability of high speed photography of such shots was appreciated, although the capabilities of cameras were very limited. The author recalls a film of about 1910 entitled prophetically " The Pirates of 1920," in which model aeroplane and airship shots were inter-cut with full-scale shots.

It has often been said that British production led the world prior to the first World War. The proof is to be found in the large number of studios functioning in 1913, of which no fewer than 27 have been listed.

V. PHOTOGRAPHY

The cameraman, the sound recordist, and the laboratory worker owe a vast debt to the small band of scientists who have perfected the modern film stock and standardised its processing. First must be mentioned the names of Hurter and Driffield, whose researches form the basis of the whole of the science of sensitometry.

It is noteworthy that the first eight names of whom one thinks in connection with photographic progress are all British. First comes the name of Wratten, in the persons of the grandfather and father of the B.K.S. President ; they were the first to develop colour sensitising dyes. Their work in the Kodak organisation has been continued by Dr. Shepherd and Dr. Mees. In the Ilford organisation their opposite numbers are the late Drs. Renwick and Olaf Bloch. In the basic study of photographic phenomena Professors Mott and Gurney are pre-eminent.

Studio Illuminants

Improvements in film stocks have led to corresponding developments in light sources. The Westminster arc was used in studios throughout the world. The recent developments in discharge lighting owe their origin to the mercury vapour tube developed by Cooper-Hewitt—commonly used in the early days for general lighting, when its high ultra-violet content made it particularly actinic to the ortho stocks of those days.

Optics

A tradition that dies very hard is that German optics lead the world. Whatever truth there may have been in this idea a quarter of a century ago, of recent years it has been quite unfounded. To-day, British lenses are unquestionably superior to the products of any other country, as is demon-

strated by the fact that practically every film, British or American, is photographed with British lenses.

It is worth recalling too that the idea of " coating " or " blooming " lenses to avoid reflection losses was first discovered by chance by Dennis Taylor, of Taylor, Taylor & Hobson, who was responsible for working out the theory of the process.

VI. COLOUR

It is generally held that all systems of colour kinematography are based upon the researches of Ducos du Hauron. As early as 1861, however, Clerk Maxwell had demonstrated a three-colour additive process of photography. Friese-Greene was obviously aware of this work when he built the camera of Fig. 3. It is fitted with two lenses, and runs two films with provision for filters. In 1898 he demonstrated a camera alternatively fitted with a lens divided into three sectors, or a rotary shutter—the prototype of innumerable colour systems of a later date.

Additive Processes

The first commercially successful colour system in the world was, of course, Kinemacolor, a system based on the patents of George A. Smith, which owed much to the work of Moy, Newman, Vinten and William Engelke of Wrench's in providing special equipment. Kinemacolor, of course, ran uncoloured film, the colours being obtained by red and green sectors on the projector.

Friese-Greene himself around the time of the 1914–18 war was working on a system in which alternate frames of the film were tinted ; the author recalls seeing him turning a camera at the Cricks & Martin studios. Kinemacolor were financially ruined as a result of patent litigation with Friese-Greene. His son Claude, whom many of us knew so well, carried on with his experiments in which the author co-operated. By courtesy of Mr. A. E. Ellis of Pathé Pictures, the author is able to show a length of his work, which in those days we thought quite an outstanding achievement.

(*The section of film here projected showed very faint colours and bad colour pulsation, due no doubt to fading of the dyes.*)

To list the innumerable additive processes which have had their origin in this country would be futile. Zoëchrome, Raycol, and Trucolor are but three of them. All were based upon the same principles as Friese-Greene's, but none showed much promise of success.

The one outstanding exception to the foregoing remarks is, of course, Dufaycolor. Although of French origin, the process was made practicable by researches carried out in this country, in which Major A. Cornwell-Clyne played an important part.

Subtractive Processes

In the production of subtractive processes, which it appears will henceforth hold the field, this country cannot claim any outstanding contribution. The Multicolour or Polychromide process developed in the 1920's by Aaron Hamburger no doubt contributed indirectly to the success of other subtractive systems. It is worth recalling that the Gasparcolor process, although invented by a Hungarian chemist, was developed in this country.

VII. SOUND

It is a matter of history that the first talking picture ever produced resulted from the marrying by Kennedy Dickson of Edison's phonograph and the newly-invented moving picture. For many years attempts were periodically made to produce " talkies " with the aid of the gramophone record. It is worthy of comment that Eugene Lauste who worked with Edison, and his son

Emil, whose recent death we mourn, were associated with Leon Gaumont, whose Chronophone system was run by Colonel Bromhead at the London Hippodrome during 1908 and 1909.

But the outstanding system of that time, at least in this country, was Cinephone, made under the joint patents of William Jeapes and Will Barker ; in this system, synchronism between gramophone and the hand-driven projector was effected by means of a dial photographed on the film, the hand of which had to be kept in step with a similar dial driven by the projector. Capt. Barker states that during 1908 to 1910 no fewer than 483 kinemas were equipped with this system, and three studios were occupied in providing programmes.

Two other workers of the same period were Donisthorpe and Thomassin. The former employed mechanical coupling between gramophone and projector. The Thomassin Animatophone the author recalls running at a much later period ; in this, synchronism was maintained by an electric connection from the gramophone to a dial in the projection room.

Recording on Film

The origin of the sound film, as distinct from the film with accompanying sound on discs, is generally attributed to Eugene Lauste. But four years before his patent, the principle of oscillographic recording was very fully set out by William Duddell (whose name is of course associated with oscillographs) in British patent No. 24,546 of 1902.

Nevertheless, Lauste's patent No. 18,057 of 1906 is a remarkable essay on the requirements of sound-on-film recording. The essentials of the process were clearly set out and the possibility of recording either by means of a glow-lamp (variable density) or a vibrating shutter or mirror (variable width) was discussed.

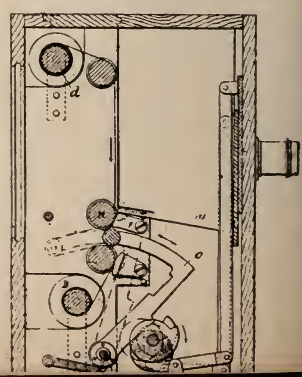
Electronic Amplification

But the problem which confronted all other inventors remained : how was the sound to be magnified to be heard by a large audience ? The possibilities of electronic amplification consequent upon the discovery by Sir Ambrose Fleming of the thermionic valve, altered the whole situation.

An early worker in the field of electronics was Lee de Forest, an American, whose researches resulted in the grid being added to Fleming's diode. At an early date he carried out research on film recording, most of it in this country. In 1925, at the Wembley Exhibition, thousands of spectators strained their ears to understand the sound accompanying some films of several British comedians. As we shall shortly have an opportunity of hearing, reproduction of the films on more modern equipment shows that the quality of recording was extremely good—it was the reproduction that failed to reach the same standard.

Fig. 3. William Friese-Greene's Camera (1890)

Fig. 4. Mechanism of Friese-Greene's Camera



The system employed was that of variable-density sound and picture on one negative—an unhappy compromise that did injustice to both cameraman and recordist. Arthur Pereira, who had much to do with the technical development of the process, recalls that sometimes the glow lamp would die, and the picture would be photographed without the accompanying sound. The company later became British Talking Pictures.

(*An early De Forest Phonofilm was projected, the sound showing a surprisingly high quality.*)

About the same time, two Danish inventors, A. Petersen and A. Poulsen, were working on the same problems. They employed a separate sound film the whole width of which between perforations was occupied by the sound modulations. They brought their system to this country, where Dr. O. K. Kolb, of the Gaumont Company, perfected it, creating the system known as British Acoustic.

Nevertheless, it is only fair to say that as far as the general public was concerned it is the developments which reached us from America in the late twenties which put sound on the map ; progress since those early days has been a matter of competition between technicians in all countries, in which it may fairly be claimed that the British technician has held his own.

One name that should be mentioned in this connection is that of Capt. Round. At a time when noiseless recording was seemingly tied up by comprehensive patents, he devised a method of producing a noiseless track, which was operated in a number of studios. He was also a pioneer of the moving-coil microphone and of the dry-damped oscillograph.

VIII. CONCLUSION

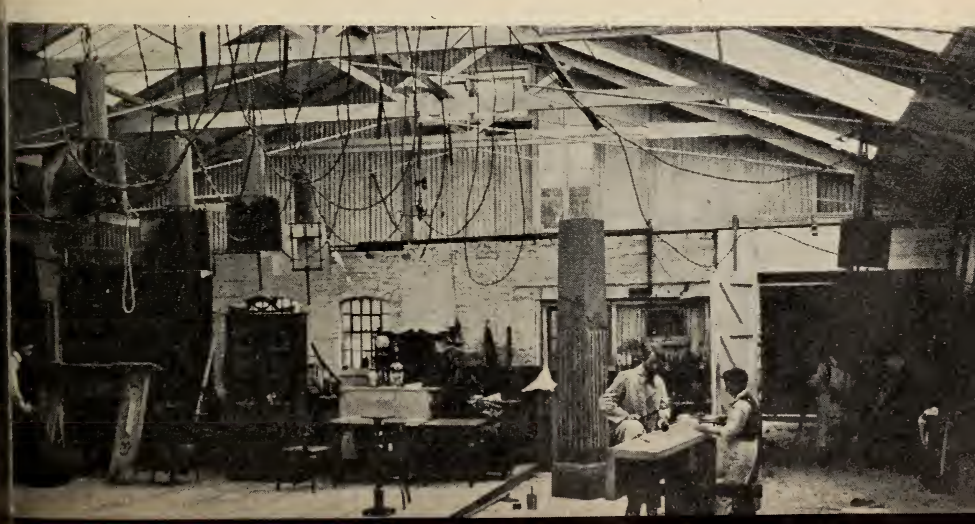
It would be quite impossible in one paper even to mention the many engineers, photographers and other technicians whose work has contributed to the growing supremacy of British films. Equally, it would be unfair to suggest that the technician should receive all, or even a major portion, of the credit, much of which must go to those whose contributions are of an artistic nature.

Nevertheless, the British technician must take his share of the credit in the increasing frequency with which one hears the remark, " I always prefer British films."

Acknowledgments

In conclusion, the author must express his thanks for the assistance given him in the preparation and presentation of this paper.

Fig. 5. Studio of Cricks and Martin, Ltd., Waddon New Road, Croydon (circa 1910)



Thanks are first due to Mr. Baynham Honri, who has not only read the paper on behalf of the author, but has assisted materially in the preparation of it, and in the provision of slides. The author is also grateful to Mr. A. E. Ellis, of Pathé Pictures, for the loan of the Friese-Greene colour film; to Mr. S. K. Wilson, of Soundcraft, Ltd., for the loan of the de Forest film; to Mr. S. J. Cox for the loan of the early Friese-Greene camera; to Mr. P. H. Bastie for the early Moy projector; and to Miss Rachael Low, of the British Film Institute, for having made available the MS. of the forthcoming publication, *The First Ten Years of British Cinema.*

The author's appreciation must also be expressed for the information provided by the following, which has assisted in assuring the authenticity of the paper:

Capt. W. Barker; Mr. P. H. Bastie; Mr. E. E. Blake; Col. A. C. Bromhead; Mr. W. Buckstone; Mr. W. M. Harcourt; Mr. Cecil Hepworth; Mr. L. J. Hibbert; Dr. O. K. Kolb; Mr. E. Lindgren; Mr. A. Pereira; Mr. C. M. Williamson; and Mr. I. D. Wratten.

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EARLY EXPERIENCES

To mark the Fiftieth Anniversary year of the first public film shows a number of veterans gave short talks on their experiences, following the paper by Mr. R. H. Cricks.

Mr. P. H. Bastie: I suppose I am one of the oldest kinematograph veterans in the room; my experience goes back over 50 years. In later years, with my late friend, Ernest F. Moy, I formed the Cinematograph Company, and we made all the mechanism: cameras, perforators, printers, developing gear and all other details required.

We put a studio on the roof of the works where we made short films. In those days 50 ft. was the standard length of a film. We wrote little plays and rehearsed them to a stop watch, because if we were too slow we lost the finish and if we were too quick we had a long blank at the end.

We made a number of topical films, such as Mr. Gladstone's funeral. One of the most interesting was made after the relief of Mafeking. We took the film back to the works, printed and developed it, took it down to the Empire Music Hall, where it was shown the same night. That must be one of the earliest occasions of a topical subject being shown the same day at a music hall.

Mr. G. Quarmby: My only claim to fame is that I was one of the earliest British film stars, although I did not know it until afterwards. I was born in a village in Yorkshire towards the end of the last century and in that village was a firm of photographers who made money by making postcards. They opened up in Paris, London, and New York, and when Lumière's pictures came along Bamforth's thought there might be something in it and got them to Yorkshire. They got the whole village to act as supers.

One of my earliest appearances was when I was fetched out of school and sent to the top of a hill with a toboggan. They used to attract one or two famous people from London and they made use of the mill people: everybody liked the films, it meant a shorter working day.

Mr. W. Buckstone: I did not enter the motion picture business until 1909, but I had made two earlier attempts. The first occasion was in 1903, when Mr. J. McDowell was showing moving pictures at the Palace Theatre. This was before the days of titles,

and somebody had to put a lantern slide on the screen before each film was shown ; I was allowed to do this while the lanternist was on holiday.

The second occasion was about two years later, when a syndicate was formed to make a motion picture of a wrestling match between Hackenschmidt and Madrali ; I was one of fifty who worked for hours to instal the lighting equipment at Olympia. Everything was ready to time, and the match started, but within 21 seconds of the start, one of the wrestlers was lying on his back with a broken arm. The cameraman had not taken any of the preliminaries in order to save his film for the actual match !

In 1909 I met Will G. Barker, who wanted somebody to instal the electrical plant in his new premises in Soho Square. That was when I met Mr. Bastie, who with Mr. Moy supplied most of the equipment. When the work was finished, Mr. Barker asked me if I would like to stay in the picture business.

Among the pictures we made was one of General Booth's funeral. We had a cameraman posted on the route, and as the cortège came into sight, to the strains of the Dead March, he got more and more depressed, and cranked the camera slower and slower as the procession went by. You must not have a temperament if you are taking motion pictures.

The same cameraman later photographed the finish of the Derby. It was a close finish and he became very excited. I leave you to imagine how the finish of the race appeared on the screen !

When " Sixty Years a Queen " was being made at Ealing, the property man had charge of the guns outside Delhi, which consisted of rolls of linoleum, painted to look like guns. As they had to be fired, the property man made up paper bags filled with gunpowder, with a fuse attached, and loaded the guns. He went off for a drink, and shortly after his return someone said : " Have you loaded the guns ? " He loaded them again, and went off for another drink. The guns were loaded half-a-dozen times, and you can imagine what the noise was like when the battle started.

In another picture we made in the Samuelson studios, reconstructing the events which led up to the first European war, we wanted guns in a great hurry ; I spotted some drainpipes ; we broke off two or three lengths, poked them through some convenient bushes, put in bags of gunpowder with fuses, and fired them. They were very effective, and we got away with the deception by referring to them in the title as " masked artillery."

Mr. Bert Bernard prefaced his remarks by showing a slide announcing an international prize fight in America in March, 1897. He said : A film was taken of the fight and we got to know about it and cabled for a price and ordered a copy, whatever the length. We exhibited it in various places, however, and in Sheffield it was engaged to be shown several times.

Seven years later there was a law case, the first in the industry, on the word "bioscope " The above slide was produced in the law courts in 1905 and it won the case.

Mr. Baynham Honri : I do not claim to be a veteran, but have taken a close interest in the trade since about 1909, when the " Lion's Head Brand " trade mark of Cricks and Martin was as well known as M.G.M.'s Lion is now. That was the beginning of the " middle period " of film production, 1910–1920, when most of the big films originated from Italy (such as " Cabiria," " Maciste," and " Quo Vadis ") ; but quite a number were made in England by several of the twenty-seven British Studios mentioned by Mr. Cricks. Some of these films were milestones of progress at the time, and I refer particularly to Will Barker's " Jane Shore " and " Sixty Years a Queen," to Hepworth's " Barnaby Rudge " and "David Garrick," to Clarendon's " Old St. Pauls " and " Under the Red Robe," B. & C.'s 'Battle of Waterloo," and several other spectacular costume films. Clarendon were noted for remarkable model shots, especially in " Old St. Pauls."

One of the pictures we saw this evening was a Pathé " Big Ben " comedy, probably made at the Alexandra Palace Studio (close to where the BBC's Television Studio is now located), where George Pearson later on made a number of remarkable pictures, one of which was " Heroes of the Mine," for which exteriors were taken in and around a real mine—a big step forward in actuality thus being attained. George Pearson was responsible for the original introduction of back-lighting effects in the studio, when he made a successful series of blood-curdling melodramas at the old Gaumont glasshouse studio at Shepherd's Bush, the first being " Ultus—the Man from the Dead."

Sporting films were well to the fore in early British Studio schedules, Cricks and Martin making " A Sporting Chance," and Barker " A Ride for a Bride " and " By the Shortest of Heads," and Hepworth " The Second String " and other racing pictures.

Several companies made single reel pictures, comedy and dramatic, in which the same characters featured week by week. Clarendon's highly patriotic " Lt. Daring " films were matched by the rival B. & C. Company's " Lt. Rose." And almost as familiar as the exploits of these gallant flag-lieutenants was the Folly Film Company's weekly comic reel (made in a boat house at Eel Pie Island, Twickenham) featuring " Pimple." Other comedy series were made up in Yorkshire by Bamforth (featuring " Scotty "). The Pimple films frequently had to help out their footage—especially when the weather was bad !—with long dialogue sub-titles putting over wisecracks in the manner which later became familiar in American films.

At the end of the period, the original London Film Company started up at St. Margarets, and made many first class productions, the most memorable of which were " The House of Temperley," " The Prisoner of Zenda," and " Rupert of Hentzau."

I have mentioned a few films made in this country prior to 1914 which I remember with pleasure, and which should, I think, go on record as showing that America did not always set the pace.

Mr. W. J. Sadler : My first introduction to the film business was in 1911, but my first memory was as a youngster at Wormwood Scrubs at a fair when you were invited to " come up, come up, and see the films," by a man shouting at the top and beating a drum ; you climbed the steps and paid the entrance fee, then went down them and sat on the grass.

I worked for Vinten for a number of years. I remember the Kinemacolor projector ; two firms manufactured it, Moy's and Vinten's ; it ran 32 pictures a second, and had the dog beater movement. The colour was additive, red and green filters being carried in a shutter which revolved at half speed. Colour was excellent except for fringing. A later machine was a converted Simplex, the double movement being obtained by two striker pins.

Some of the earlier films were printed by gas mantle, the printer turned his machine as well as operating the gas mantle backwards and forwards to get his density of light, so you may imagine what it must have involved in labour.

In the early days, Vinten designed a projector which was never put on the market because it was quite ahead of its time. Mr. Vinten incorporated the sprocket into the magazine to act as a trap and totally enclosed the mechanism ; I believe only one was manufactured.

Mr. Cricks mentioned Lauste. I actually heard Lauste's sound, but the difficulty was to get the sound loud enough for people to hear. A peculiarity was that it was a double-width film, on one side was the picture and on the other was sound, very similar to that exhibited by British Acoustic. I also had occasion to visit the de Forest studios at Clapham and saw some of the earlier sound pictures being photographed there.

In regard to developing machines, I never knew what our friend Hepworth used and was intrigued to learn that it was a long flat tank. The earliest ones I know were those built for Topical Budget, in the same form as now.

Mr. R. Hayward : I have just arrived from New Zealand and I esteem it a great honour to be able to speak amongst the veterans of the film business here.

I left this country as a child in 1905 with a combination known as " West's Pictures and the Brescians." We were amongst the first to screen films with the electric arc lamp as an illuminant, throughout Australia and New Zealand. We had the agency for Urban projectors, and films were screened together with a musical programme.

After three tours the company split up and its members settled in New Zealand ; my father and my uncle established a theatre chain. This later developed into the Fuller-Hayward Theatre Circuit of which my uncle, Henry Hayward, was the president, and always a strong supporter of British films. Many of the films mentioned here to-night were screened in New Zealand. I particularly remember " Rob Roy " and the " Pimple " comedies with the titles written in doggerel.

I started in the exhibition business turning the bottom spool in the days before take-ups were reliable. In those days we used spools made of the 3-ply bottoms of cane chairs, and this probably led to the fact that in New Zealand to-day we use 3-ply 2,000 ft. spools for touring the films, a method that has proved most satisfactory as the film gets knocked about much less with this system.

At an early age I went into the film production business, studying under Australians and Americans at a time when an Australian company brought over Wilfred Lucas and his wife, Bess Meridith, to make a series of Australian " Westerns." A number of these films were screened here.

In 1920 I returned to New Zealand and started making pictures on my own account.

I specialised in historical outdoor dramas dealing with the Maori War and pioneering period, rather like American " Westerns."

For the last five years I have been with the New Zealand Government National Film Unit making documentaries and news-reels.

Up to the outbreak of war we had no studios or laboratories to speak of, and we did everything ourselves from the writing of the script to the finished production. Now we have a studio with modern equipment. The Government is turning out a weekly newsreel and numerous documentaries.

In connection with the exhibition industry in New Zealand, we have a number of fine theatres and our equipment is fairly modern.

We have one thing probably unique in the British Empire, that is theatres that show British films exclusively.

With regard to stories of old film production, there is one story which stands out in my mind. I was making a picture about 1925 and wanted some pictures of the old artillery so I advertised and managed to get a team of gentlemen who had been with the Royal Artillery and who were prepared to operate the guns. We borrowed three old guns which had a breech of the unrepeating screw type, the shells we had made to fire out of them had a fuse on them and it was impossible to shut the breech properly and in the middle of the battle one of the guns fired at both ends and set fire to the gunner's whiskers and somebody swamped him with a canvas bucket of water.

I hope to send a complete report of Mr. Cricks's paper to New Zealand and to take back some of the fine sentiments I have heard here to-night.

ASSOCIATION FRANCAISE des INGENIEURS et TECHNICIENS du CINEMA

The paper on " British Influence in the Technical Development of Kinematography " was read to the French technical society by its secretary, M. Jean Vivié.

Following the paper, a discussion took place, during which it was suggested that Friese-Greene's camera of 1890 was not intended for recording stereoscopic or two-colour pairs of images, but that it embodied the principle earlier adopted by the French engineer, LePrince, of the successive exposure of images on each of two films, the films moving alternately. It was pointed out that the two cams visible in the photograph were arranged in suitable relation for such successive exposures.

At a subsequent meeting of the Association, the film prepared by the B.K.S. for the Physical Society Exhibition was projected. This film has already been shown at the Brussels Film Festival.

PHYSICAL SOCIETY ACOUSTICS GROUP

The Acoustics Group of the Physical Society was formed in February, 1947, to provide an opportunity for the very varied types of workers engaged on acoustical problems to meet and discuss the scientific and technical implications of their work. It is hoped to arrange for some six meetings per year, including at least one special summer meeting which will take the form of a symposium covering a particular aspect of acoustical investigation ; reprints of papers will be circulated to the members when available, and it is hoped to arrange for research panels on special topics.

The Group operates under the authority of the Council of the Physical Society. Membership is open both to members of the Society and also to non-members. Annual subscription to B.K.S. members is 5s.

The committee invites members to submit papers for reading at meetings of the Group and requests that any member who is preparing a paper dealing with acoustics, for publication by or reading before any other Society or Institution, should inform the committee of the Group of his intention with regard to the paper. The committee may then be able to obtain reprints of the paper and may also make special arrangements for members of the Group to attend the reading of the paper, or alternatively the author may be invited to give a separate reading of the paper to the Group.

Information with regard to papers should be sent to the Joint Secretaries of the Acoustics Group, Messrs. W. A. Allen and A. T. Pickles, The Physical Society, 1 Lowther Gardens, Prince Consort Road, S.W.7.

FILMS IN AIRCRAFT MANUFACTURE AND TESTING

J. C. Thackeray *

Read to the B.K.S. Sub-standard Film Division on September 25th, 1946.

IT is probably true to say that the 16 mm. film has only been used in the aircraft industry to any great extent during the past eight years. Strange to relate in many cases it was first used in the industry purely by accident. The still photographer of an aircraft firm is asked to take a picture of a fast low flying 'plane at close range, and it is suggested that he borrows the kine camera belonging to the Managing Director, and that one of the frames should be enlarged.

From these crude beginnings many firms have built up film units doing every conceivable form of technical work, and I may add that the work done has proved of enormous value during the war, and is still doing so in peace.

It was very quickly realised that it was possible to capture both fast and slow movement with the help of the kine camera, and with this end in mind problems of every kind involving movement were brought to the unit for an answer. One thing I have learnt in dealing with technicians is that, because I am able to use lenses with apertures of $f/1.5$ they are under the fixed impression that it is possible at any time of the day or night to shoot moving objects, even though you are unable to see your hand in front of your face.

Study of Aircraft Performance

A valuable application of kinematography is in the study of aircraft performance in take-off and landing. As shown in the drawing, two cameras are used, separated by a known distance. Around each camera is a number of posts at 5° intervals, each bearing a large number indicating its angle. The cameras are trained upon the aircraft, photographing also these figures, which indicate the orientation of the aircraft. Simultaneously flashing lamps are photographed on the two films in order to permit of synchronism.

It is possible by simple triangulation to calculate the length of take-off, and, as shown in the sketch, the rate of climb.

Records are always kept of the initial first flight of a new 'plane, and sometimes quite startling results are captured ; you will see afterwards a 'plane crashing on one of these flights. It is also customary nowadays for air-to-air shots to be included in the flying record of the new aircraft.

Recording Instrument Dials

As aircraft flew faster and faster the degree of accuracy called for in the instruments and controls became more exacting ; this was connected again with a further increase in the number of instruments and controls fitted to an aircraft, particularly with the large four-engined type. It became increasingly

* Miles Aircraft, Ltd.

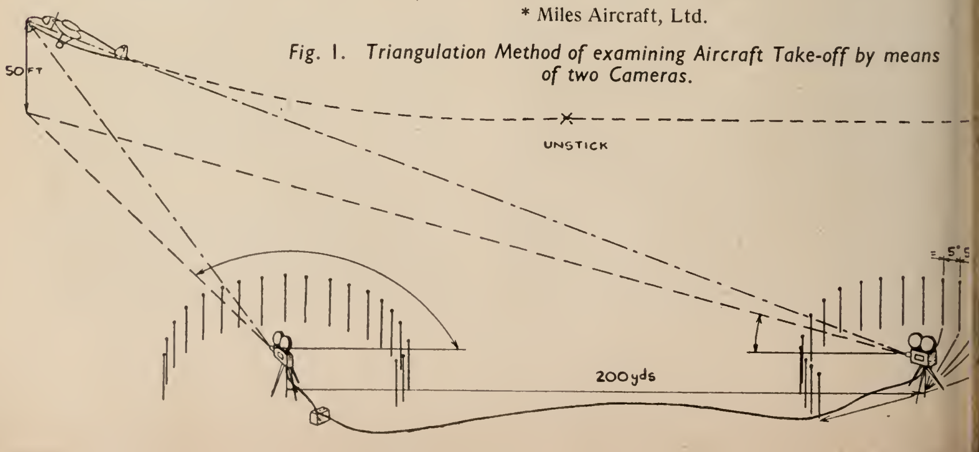

Fig. 1. Triangulation Method of examining Aircraft Take-off by means of two Cameras.

difficult for a test pilot to give his undivided attention to the terrifying array of gadgets. This is where the kine camera proved of enormous value.

In order to provide records of the array of dials, a light-tight box was made to fit over the instrument panel, and to carry the camera and lights. When the pilot presses a button, the lights are switched on and the camera exposes one frame. The type of record obtained is shown in Fig. 3.

Wind-tunnel Records

The wind-tunnel plays a very big part in the life of an aircraft factory, and photography in this connection has proved indispensable. It is interesting to note that the modern design for a wind-tunnel includes special provision in the tunnel of photographic lighting suitable for both still and kine work. The " flow " over an aircraft is watched through the inspection panels and from the behaviour of small pieces of wool stuck all over the various surfaces of the model the aerodynamic expert is able to assess the potential flying qualities of any given prototype aircraft. Smoke is also used for watching the " flow " over a model, and I shall be showing you some high speed kine shots taken in a smoke wind-tunnel.

The wool tuft technique is employed on the full size aircraft, and in early days it was customary for a pilot to study the behaviour of these tufts whilst

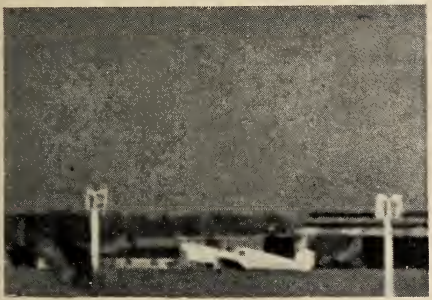

Fig. 2. Film of Aircraft Touch-down, showing Angular Marking Posts.

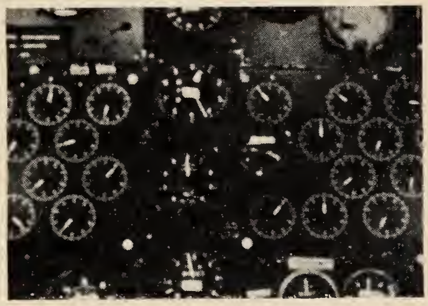

Fig. 3. Enlargement of Frame of Aircraft Instrument Panel.

flying the " plane " ; nowadays he is relieved of this responsibility, and by fixing a camera in the aircraft a complete record at any given time is obtained.

Training and Publicity

The 16 mm. film has played a big part in the training of work-people and technicians in their own particular sphere, and I firmly believe that it will play an even bigger part in the years to come. We have made films showing our employees the good work they have done—and some of the bad work—and the reactions have always been satisfactory. I think the presentation of the subject is of paramount importance in this type of film, and a great deal of latitude is allowed the cameraman in the way he tackles the subject and gets it over to his works audience.

Advertising, of course, can be a major side of a film unit, and a certain number of the staff can be allocated to carrying out this work, and nothing else. Here the approach is quite different. The object of the film is to try to sell the product, and I must confess that the professional company can probably do a better job of this work than the unit contained within the firm. The film unit does, however, have one great advantage inasmuch as they are able to arrange and plan their shooting on the spot, and are in constant daily touch with the project itself.

The paper was illustrated by a number of films, including a publicity film in Kodachrome.

PROVINCIAL SECTIONS

The Provincial Sections of the Theatre Division have been very active during the past session. A number of meetings have been held in each centre, and have been well attended.

Steps are now proceeding for the formation of these Sections into Branches of the Society.

MANCHESTER SECTION

UNDER the chairmanship of Mr. C. H. Tuckett, a series of monthly meetings has been held in the theatre of the Manchester Geographical Society, to whom the Society is grateful. The secretary is Mr. A. Wigley.

Electronics and the Kinema

The session opened with a meeting on September 10th, 1946, when Mr. Geoffrey Parr, A.M.I.E.E., F.B.K.S., delivered a paper which covered the same ground as the three papers which he had previously delivered to the Theatre Division in London.[1] An interesting discussion ensued.

DISCUSSION

A VISITOR : Would the lecturer explain the action of light on a selenium cell?

THE AUTHOR : There are two kinds of selenium cell. The original cell in which a thin layer of selenium was spread between two contacts, altered its resistance when light fell on it, and thus altered the value of current flowing through it. It is important to note that this cell did not generate a voltage, nor produce free electrons.

In the later form of cell, the so-called "Barrier Layer" cell, a film of selenium is coated on to a metallic backing and the light passes through a metal film deposited on the front surface of the selenium.

Electrons are liberated from the surface of the selenium in contact with the metal film (the barrier layer), and flow through the metal to the outside circuit. The advantage of these cells is the comparatively heavy emission obtainable, which enables them to be used directly connected to a meter, but they are difficult to use with valve amplification on account of their low resistance.

A MEMBER : What was the origin of the thoriated tungsten filament in valves?

THE AUTHOR : In 1924 the valve filaments were made of pure tungsten, which had the advantage of having a high melting point. The temperature could therefore be raised to nearly white heat to give the maximum emission of electrons. A short time after it was discovered, more or less accidentally, that tungsten contaminated with a trace of thorium (and pure uncontaminated tungsten is the exception rather than the rule) was capable of giving a greater emission at a temperature very little above red-heat. We know from later measurements that the work function of thoriated tungsten is 3.35 as against 4.5 of tungsten, which means that the emission is increased due to the molecules of thorium deposited on the surface of the tungsten. A good account of the properties of tungsten filaments is given by Koller in his book, "Physics of Electron Tubes."

A VISITOR : Referring back to the photocell, would it not be of advantage to use a gas-filled cell?

THE AUTHOR : The gas-filled cell is certainly more sensitive than the vacuum cell, because of the increased number of electrons produced by collision with the gas molecules. There is a certain risk in using it, however, as if the anode voltage is increased to give the maximum sensitivity the cell is liable to produce a permanent discharge between anode and cathode. This makes it behave like a gas-discharge diode and ruins the cell. The other disadvantage is that the frequency response is poor and falls to about 60% at 8,000 c/s under some conditions.

MR. C. H. TUCKETT : Can we have some information on the type of barrier-layer cell which has a high voltage output?

THE AUTHOR : This cell is really a collection of units connected in series, and is made by Evans Electroselenium, Ltd. It was shown at the Physical Society's Exhibition at the beginning of this year, and is intended to overcome the disadvantage of the low resistance selenium cell.

The Cathode-ray Tube

On October 8th, a paper on the cathode-ray tube was given by Mr. Jeff. C. Evans. The paper traced the development of the tube from the thermionic

diode, the formation of the beam of electrons by means of the Wehnelt tube or grid, and the focusing of the beam on the fluorescent screen by means of electro-static or electro-magnetic fields. The method of deflection of the beam was discussed, and the formation of images.

The paper was followed by a discussion.

The Principles of Television

The paper by Mr. Evans led up to a paper on the subject of television, delivered by Mr. T. M. C. Lance on November 12th, 1946 ; the paper had been previously read to the Theatre Division in London.[2] The meeting was exceptionally well attended.

Fluorescent Lighting

On December 3rd, a paper on fluorescent lighting was, in the absence in the United States of Mr. A. G. Penny, read by Mr. W. A. R. Stoyle, B.Sc., A.M.I.E.E. The paper will be reported in a later issue of *British Kinematography*.

Projection Optics

On January 7th, 1947, a paper on the optics of the projector was delivered by Mr. D. F. Burnett, M.A. Mr. Burnett discussed the optical system which projected a beam of light upon the screen, and the system whereby an image was superimposed on this beam. The various imperfections inherent in such systems were discussed, and the methods taken to minimise them were indicated.

Uses, Care and Maintenance of Low-tension Batteries

A paper on storage batteries as used in the kinema was delivered by Mr. J. D. Wright, B.Eng., on February 11th. This paper also will be reported in a later issue.

Kinema Engineering Efficiency

The paper previously delivered by Mr. H. E. Whitney, A.M.I.E.E., A.M.I.H.V.E., to the Theatre Division[3] was presented by him to the Manchester Section on March 11th, 1947.

Auditorium Requirements in Sound-film Presentation

The lecture season closed with the delivery, on April 8th and May 13th, of the two papers on auditorium design prepared by sub-committees of the Theatre Division and delivered at Society meetings.[4] The first, on picture presentation, was read by Mr. R. Pulman, F.B.K.S., and the second, on acoustics, by Mr. W. F. Garling, M.B.K.S., both part authors of the respective papers.

REFERENCES

1. *Proc. B.K.S. Theatre Division*, 1945/6, pp. 1, 6, and 17.
2. *Proc. B.K.S. Theatre Division*, 1945/6, p. 22.
3. *Proc. B.K.S. Theatre Division*, 1944/5, p. 19.
4. *J. Brit. Kine. Soc.*, Vol. 10, No. 2, Mar./Apr., 1947, pp. 58, 72.

NEWCASTLE-ON-TYNE SECTION

THE chairman of the Newcastle-on-Tyne Section is Mr. R. E. Greene, M.Inst.R.E., and the secretary Mr. Edward Turner. Their meetings are held in the Neville Hall, Neville Street, Newcastle-on-Tyne.

The Principles of Amplifiers and Amplification

The first meeting of the session was held on October 1st, 1946, when a paper was delivered by Mr. George Dobson on the subject of amplification The paper will be summarised in a later issue of *British Kinematography*.

Unit Specialisation in Kinema Equipment

At the meeting held on November 5th, the paper delivered by Mr. S. B.

Swingler to the Theatre Division (to be printed in a subsequent issue this Journal) was read by Mr. C. E. Perry.

Fluorescent Lighting

On December 10th, the paper on fluorescent lighting delivered the previous week to the Manchester Section by Mr. W. A. R. Stoyle, B.Sc., A.M.I.E.E., was repeated. This also will be reported in a later issue.

Auditorium Requirements : I.—Projection

The first of the two papers on auditorium design[1] prepared by sub-committees of the Theatre Division, and read at meetings of the Society, was delivered on January 7th, 1947, by Mr. R. Pulman. The following discussion ensued.

DISCUSSION

Mr. Wilson : Regarding illuminated screen borders, we are used to seeing the borders illuminated, but the picture terminating in a defined black surround.

Mr. Pulman : While the ordinary picture with the black surround is normal, it will be most desirable to introduce a means of dissolving a picture at the edge.

Mr. Wilson : Light other than that on the screen is very distracting. As exit boxes have to be clearly seen, will this work against the engineers as far as placing illumination ?

Mr. Pulman : As exit boxes are generally at the side of the auditorium they do not affect screen illumination, and architects should not design auditoria where such distraction will exist.

Mr. Lewis : Some theatres have exit boxes placed each side of the proscenium arch, can anything be done with this ?

Mr. Pulman : Exits within visual angle are a distraction, but unfortunately there is little that can be done about it. It is just another example of lack of co-operation with the architect during design. The B.K.S. is offering technical advice so that an architect cannot later say " nobody told me."

Mr. Wilson : Can you advise us as to the best height of screen from stage ?

Mr. Pulman : You are bound by the eye-strain regulations. It depends upon the distance of front stalls seating from the screen as shown on the slides.

Mr. Watson : Can you tell us briefly what a lenticulated screen is?

Mr. Pulman : It has small lenses instead of balls as in the glass beaded screen. They are arranged to be directional down to the seats where required and do not send rays into the roof. I have seen a Technicolor film on a lenticulated screen and was really amazed with the marked difference.

Mr. Watson : What arrangements can be made for cleaning this type of screen ?

Mr. Pulman : Glass beaded screens can be washed if this is done very carefully, but I would not like to do the job.

Auditorium Requirements : II.—Acoustics

The second of the above papers, on the subject of acoustics[2], was, in the unavoidable absence of Mr. L. Knopp, who had been expected, read by Mr. George Dobson on February 4th. It was followed by a discussion.

DISCUSSION

Mr. Wilson : In some kinemas the rear of the stalls frequently has glass partitions as draught excluders. Is this detrimental to sound reproduction ?

Mr. Dobson : Yes ; it is definitely detrimental.

Mr. Wilson : On one slide you showed an inverse curved wall ; could you amplify the reasons for having such a wall ?

Mr. Dobson : Sound is akin to light and the incident angle of reflection from such a wall is such as to diffuse the sound waves away from the audience.

Mr. Wilson : What are the tests for reverberation—or are these trade secrets ?

Mr. Dobson : At one time a spark gap and microphone were used, but a more reliable method is to work this from the architect's plans.

Mr. Wilson : In one kinema I know there can be heard waves of hum which can be detected at several points down the auditorium—with silent patches in between.

Mr. Dobson : This is due to the 100 cycle hum from an energised speaker field being reflected back from the rear wall—the return wave being 180 degrees out of phase with the original.

Luncheon arranged by the Newcastle-on-Tyne Section on May 6th, 1947
Back row (left to right) : Messrs. Fraser, Turner (Hon. Secretary), Brown, Dobson, Stuart, Fade, Nicholson, Wilson, Eadie, Watson, Phillips, and Lewis.
Front Row (left to right) : Mesdames Fraser, Turner, Greene, Mr. Greene (Chairman), Mesdames Stuart, Nicholson and Wilson.

Uses, Care and Maintenance of Low-tension Batteries

The paper on storage batteries by Mr. J. D. Wright, B.Eng., previously delivered to the Manchester Section, was read on March 4th. The report will appear in a later issue.

Heating and Ventilating Equipment

A paper by Mr. L. W. J. Henton, A.M.I.H.V.E.[3], previously delivered to the Society, was read by Mr. J. T. Leake, M.I.H.V.E., on April 8th. A discussion followed.

DISCUSSION

Mr. WILSON : On the question of fuel, why is it coal or coke is always used ? Has oil been tried ?

Mr. LEAKE : Yes ; as a matter of fact we have put a plant in a particular place recently. Oil is much dearer than solid fuel, but you get twice the calorific value from it compared with coal. Costs are much greater.

Mr. WILSON : Has gas any advantages ?

Mr. LEAKE : Gas is also dearer than solid fuel, and as far as I am aware has not been used in kinemas in this district. The extra cost may be cancelled out by dispensing with the services of a boiler attendant.

Mr. WILSON : In the ordinary system pumps are always used. If the pump breaks down what are the dangers ?

Mr. LEAKE : Referring to the brochure of a particular make of pump, you will notice it has an automatically operated by-pass. This removes any danger in the event of a breakdown. Where this by-pass is not an automatic feature, hand-operated by-pass valves should be fitted.

Mr. WATSON : There surely would be no danger because the ordinary convection flow will be operating.

Mr. LEAKE : Poor results would be noticed, but there would be no danger if the fire is damped.

Problems of 16 mm. Projection

At the meeting of May 6th, a symposium arranged by Mr. H. S. Hind, A.M.I.E.E., M.B.K.S., A.R.P.S., on sub-standard projection, was read by Mr. G. Dobson. The paper was originally presented to the Sub-standard Division, and will be reported in a later issue.

The meeting was followed by an informal luncheon at the Queen's Café, Newcastle-on-Tyne.

Discussion Meeting

The season closed on June 3rd, 1947, by a meeting devoted to general technical discussion, and to consideration of the lecture programme for the 1947/48 session.

REFERENCES

1. *J. Brit. Kine. Soc.*, Vol. 10, No. 2, Mar./Apr., 1947, p. 58.
2. *J. Brit. Kine. Soc.*, Vol. 10, No. 2, Mar./Apr., 1947, p. 72.
3. *J. Brit. Kine. Soc.*, Vol. 7, No. 3, July/Sept., 1944, p. 92.

TECHNICAL ABSTRACTS

Certain of the following abstracts are reprinted by courtesy of Messrs. Kodak Ltd. Most of the periodicals abstracted may be seen in the Society's Library.

PROPOSED FRENCH STANDARDS IN SENSITOMETRY.

M. Roulleau, *Sci. Ind. Phot.*, Vol. (2)13, March–April, 1942, pp. 49–60.

Comprehensive standards are proposed for nearly all black-and-white sensitised materials with specific details and tolerances for every stage in the testing. The testing procedures generally agree with the American Standards Association tests for photographic speed, but the criterion for locating the speed point differs from the A.S.A. system. For most emulsions, this criterion is the log E value at the intersection of the two tangents to the toe of the characteristic curve having a slope of 0.2 gamma and 0.4 gamma. Sensitised materials on both transparent and non-transparent supports are classified as : (1) rapid negative (amateur) ; (2) slow negative (motion picture) ; (3) reversible ; and (4) positive. Each group has its own testing procedure and criteria for speed, contrast, and other properties. Arbitrary limits in spectral sensitivity are set up for determining the type of sensitivity and spectral range of a given emulsion. Two means of expressing the speed are proposed : a value of the sensitivity and a " factor of exposure," evaluated in phot-seconds and lux-seconds (metre-candle-seconds), respectively. R. S. B.

INTENSIVE EXHAUSTION OF MOTION-PICTURE DEVELOPER BATHS.

R. Martinez, *Ion*, Vol. 5, No. 46, May, 1945, pp. 327–331.

Gamma-time curves showing the progress of photographic development have the form characteristic of first-order reactions with parameters changing progressively upon exhaustion, in accordance with the decreasing development rate. In the continuous-machine processing of motion-picture film, the use of developers to the point of extreme degrees of exhaustion is not usually permissible because the time of development would be too long. Because of the form of the development characteristic, a higher over-all development rate can be obtained for a given degree of developer exhaustion (utilisation) if a counter-flow system is used so that development is begun in the comparatively exhausted bath and completed in the comparatively fresh bath. This was treated graphically for a two-tank system. With positive film, the area of film treated with a given volume of developer can be increased greatly ; in the case of negative film, only 30 per cent. C. E. I.

COURSE OF DEVELOPMENT AT DIFFERENT pH. II. A STUDY OF METOL-HYDROQUINONE DEVELOPER.

E. R. Elvegard, *Z.wiss. Phot.*, Vol. 42, No. 4–7, 1943, pp. 65–80.

The author studied the kinetics of development by solutions containing different proportions of metol and hydroquinone, and at different pH values. The data confirm the author's formula for density as a function of time of development and exposure (*Ibid.*, Vol. 42, 1943, p. 1). The time of development required to reach a given gamma value is determined by two factors : the induction period and the rate of increase of gamma beyond it. The dependence of these two factors on the pH and composition of the developing solution is discussed. With the formula tested (containing 1 gm. potassium bromide per litre), the confluence point of the family of characteristic curves moves upwards and towards higher log E values as the pH increases up to 10 ; beyond 10, the point moves towards lower log E values. The rate of increase of gamma increases at first with pH, but passes through a maximum around $p\text{H}=10$, and is often smaller at $p\text{H}=12.5$ than at 8.5, particularly if the developer contains little hydroquinone. The author suggests that a connection exists between the sudden changes observed in the neighbourhood of $p\text{H}=10$ and the onset of hydrolysis of the silver bromide. T. H. J.

ROENTGEN KINEMATOGRAPHY AS A ROUTINE METHOD.

B. S. Holmgren, *Acta radiologica*, Vol. 26, No. 3 1945, pp. 286–292.

The advantages of modern roentgen kinematography in the form of the indirect method are discussed. Emphasis is laid on the value of the routine use of the method for the study of deglutition and the esophagus and also in connection with arteriography and venography. AUTHOR'S ABSTRACT.

THE PHOTOMETRY AND COLORIMETRY OF ELECTRIC DISCHARGE LAMPS.

G. T. Winch, *Light and Lighting*, Vol. 39, March, 1946, pp. 41–43.

The speaker described some improvements in a photo-electric colorimeter in which the

light from the lamp under test is dispersed into a spectrum which is suitably masked to give, in combination with a photo-electric cell, not only the colours of the source in C.I.E. units, but also the number of lumens and the relative luminosities in eight agreed wavelength bands. After discussing the period of stabilisation of discharge lamps after switching on, he remarked that although the lumens output decreases during the first 100 hours of life, there is no indication of any change in colour. Dealing with the apparent colour temperature of fluorescent lamps he stated that the daylight type were almost black body, but that the warm-white type were not so. R. B. M.

THE SCOPHONY HIGH-SPEED CAMERA.

Scophony, Ltd., *Phot. J.*, Vol. 86B, March–April, 1946, pp. 42–46.

The Scophony High-Speed Camera described takes 49 pictures at a time on a strip of standard 35 mm. film at the rate of 10,000 pictures a second. The film is supported on a uniformly rotating drum and the image stabilised thereon by reflection from a prism concentric with and rigidly attached to the drum. The optical, mechanical and electrical problems connected with the design are discussed. AUTHOR'S ABSTRACT.

A NEW 16 MM. PROFESSIONAL CAMERA.

F. F. Baker, *J. Soc. Mot. Pic. Eng.*, Feb., 1947, p. 157.

The Mitchell 16 mm. camera is a miniature replica of the 35 mm. model. It has a register-pin movement, 175° shutter opening with hand dissolve, 4-lens turret with slide-over focusing, and 400 ft. magazines. Double-perforated film has to be used. R. H. C.

ESSENTIAL REQUIREMENTS OF SOUND TRANSDUCTION.

R. H. Cricks, *Ideal Kinema*, Vol. 12, 1946, April 11, p. xxi ; May 16, p. xix ; June 13, p. xix ; July 11, p. xix.

The general principles and methods of recording sound on film are reviewed, and the relative merits of the various types of sound track, variable density and variable area, are mentioned, particularly in relation to the photographic material. The sound films at present available in this country resolve 50 to 90 lines per millimetre, but it is expected that film resolving up to 150 lines per millimetre will be obtainable in the future. An essential in the recording and reproduction of sound, is that the film shall move past the scanning point at a uniform velocity. This necessitates accurate combination of momentum, resilience, and friction in the recording camera and projector. Suitable design of the optical system is important, particularly to give uniform illumination over the scanning slit, the Eastman Kodak toroidal lens being most satisfactory from the author's point of view. G. W. S.

TONE CONTROL FOR RE-RECORDING.

C. O. Slyfield, *J. Soc. Mot. Pic. Eng.*, Dec., 1946, p. 453.

When mixing dialogue with music or other background sounds, the volume level of the latter may be faded down during dialogue sections, and restored to normal, with accurate timing by the use of a simple control track.

The control track includes sections of constant note track cut in to synchronise with dialogue sequences, and the output of the tone control play-off is used to control the gain of an amplifier inserted in the lines from music and effects play-off heads. N. L.

AN IMPROVED 200-MIL PUSH-PULL DENSITY MODULATOR.

J. G. Frayne, T. B. Cunningham, and V. Pagliarulo, *J. Soc. Mot. Pic. Eng.*, Dec., 1946. p. 494.

The modulator includes a newly developed light valve having three ribbons, of which the centre one only carries the signal, the outer ones providing the noise reduction control. The images of the two slits so formed are aligned by the use of an inverter prism in one light beam and a compensator in the other.

The design of the light valve is described together with its associated optics, and performance data given together with a mathematical analysis of the operation for both three-ribbon and four-ribbon types. N. L.

A NEW SELSYN INTERLOCK SELECTION SYSTEM.

D. J. Bloomberg and W. O. Watson, *J. Soc. Mot. Pic. Eng.*, Dec., 1946, p. 469.

In order to avoid the cumbersome patch plug and cable system normally used in selecting and setting up Selsyn systems, a new type of multi-way switch was developed. By rotary movement, the switch selects one of five positions without contacting any intermediate position, the contacts being closed after selection by axial movement of the knob. N. L.

THE COUNCIL

Meeting of May 7th, 1947

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), C. Cabirol, R. B. Hartley, L. Knopp, A. G. D. West (*Past President*), C. H. Bell (*representing Theatre Division*), and R. H. Cricks (*Secretary*).

Annual Accounts.—Accounts for the year 1946 were submitted ; it was reported that the Board of Trade required separate accounts for the half-year prior to incorporation of the Society. The accounts were approved for submission to the Ordinary Meeting.

Election of Council.—Messrs. N. Leevers and A. H. C. Rouse were appointed scrutineers.

Qualifications for Membership.—It was reported that the Society's Solicitor had prepared revised wording for By-law 3. It was agreed to communicate the amendment to the membership.

Fellowship.—Draft nomination form for candidates for the Fellowship was approved.

Provincial Sections.—In accordance with recommendations of the Theatre Division Committee, the following Sub-Committee was empowered to examine the draft Branch constitution, and to submit it to the Secretaries of the Provincial Sections : Messrs. Pulman, Stringer, Swingler, and Bell. It was agreed that the Secretary should travel to Newcastle-on-Tyne and Manchester and submit the constitution to the respective committees.

Education Committee.—It was agreed that proposals concerning the award of a scholarship tenable in the two-year course at the Polytechnic should be considered at the next meeting of the Council.

Mr. J. Benson.—It was agreed that a letter of appreciation for his past services to the Society be sent to Mr. J. Benson on the occasion of his relinquishing his non-technical activities in favour of technical work on the *Ideal Kinema.*

Brussels Film Festival.—Mr. Baynham Honri reported a meeting of a committee of the C.O.I., when short films had been selected for exhibition at the Brussels Film Festival.

Publicity.—Mr. Harcourt reported that he was having notice boards prepared for display at Denham Studios, Denham Laboratories, and Pinewood Studios, to carry notices of B.K.S. meetings.

Meeting of June 4th, 1947

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), E. Oram (*Hon. Secretary*), C. Cabirol, R. B. Hartley, B. Honri,* L. Knopp, A. W. Watkins, A. G. D. West (*Past President*), R. Pulman (*representing Theatre Division*), H. S. Hind (*representing Sub-standard Division*), and R. H. Cricks (*Secretary*).

Film Production Division Representative.—A request from the Film Production Division Committee was agreed, that in view of the election as an Ordinary Member of Council of Mr. Honri an additional representative of the Division should be elected.

Committees.—A number of Committees were re-appointed (*see* inside back cover).

Fellowship.—Following upon approval of the nomination form for the Fellowship, it was agreed that the material should be re-arranged in a form suitable for inclusion in the constitution.

Branch Constitution.—Meetings of the Provincial Sections Sub-committee were reported, one of which had been attended by the secretaries of the Newcastle-on-Tyne and Manchester Sections. Draft constitution of branches had been considered.

History of British Film.—Proposals for the compilation of a technical history of the British film industry were considered, but were not approved.

Education Committee.—The sum of £50 per annum for two years was placed at the disposal of the Education Committee for the award of scholarships.

Membership Committee.—A recommendation that, in view of the necessity to restrict attendances at meetings, Members and Associates should be issued with a limited number of admission tickets for meetings was approved.

Film Mutilation Committee.—It was reported that the K.R.S. Print Managers' Committee had proposed that a number of brochures be issued to projectionists, rather than a single book, as previously proposed.

Theatre Division.—Reporting a meeting of the Theatre Division Committee, Mr. Pulman was thanked for his outstanding services to the Division.

National Illumination Committee.—Messrs. F. G. Gunn and S. B. Swingler were appointed to represent the Society on the National Illumination Committee.

* Mr. Honri, in addition to being an Ordinary Member of Council, also represents the Film Production Division.

EXECUTIVE COMMITTEE

Meeting of May 7th, 1947

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), R. H. Cricks (*Secretary*), Miss S. M. Barlow (*Assistant Secretary*).

Elections.—The following were elected :

Arthur Pereira, F.R.P.S. (Member), Kinematographer.
A. R. Pichumany Ayyar (Member), National Picture Corporation, Ltd., India.
George Morris (Associate), Cinex, Ltd.
Terence Pearson Hunter (Associate), Warner Bros.' Studios.
Eric Albert Richard Herron (Member), British Lion Studio Co., Ltd.
John Thomas Allan Haveron (Associate), Hippodrome, Shildon, Co. Durham.
John Marshall Gill (Member), RCA Photophone, Ltd.
Leslie Godfrey Keith Stanley (Associate), R.A.F.
Alexander Russell Borland, M.A. (Member), British Instructional Films, Ltd.
James Benson (Member), Technical Journalist, *Ideal Kinema.*
Leonard William Wagstaffe (Associate), British Lion Studios.
John Albert Clifford Drury (Associate), British Lion Studios.
Ernest Henry John Runkel (Associate), British Lion Studios.
Cyril George Grace (Member), Pathé Pictures.
Edward Smith Morris (Member), Polytechnic Films, Ltd.
Major William de Lane Lea, C.G. (Member), Lingua-Synchrone, Ltd., and Byron Pictures, Ltd.
Frederick Ernest Baldwick (Member), Manchester News Theatre.
H. S. Rathmill (Associate), Moston Imperial Palace, Manchester.
George Alfred Nightingale (Associate), Cinetechnic, Ltd.
Marcus James Broadway (Associate), B.M. Productions, Ltd.
William Ernest Green (Associate), Studio Film Laboratories.
Frederick Maurice Kear (Member), Pathé Equipment, Ltd.
Raymond Nutton (Associate), Pavilion, Newcastle-on-Tyne.
Robert Ritson (Member), M.G.M. Studios.

Transfers.—The following Associates were transferred to Membership :

Digamber Chatterjee, Associated Pictures, Ltd., Calcutta.
Ronald Norman Haig, Technicolor, Ltd.
Ronald Edward Jeffery, Central Picture Theatres (Lincoln), Ltd., Leeds.

Subscriptions.—It was agreed that Members, Associates, or Students voluntarily joining the Forces now that hostilities have ceased should not be excused their subscriptions.

Sub-Standard Division Committee.—Pending Mr. G. H. Sewell's absence abroad, Mr. F. V. Heath was nominated as his Deputy.

Meeting of June 4th, 1947

Present : Messrs. W. M. Harcourt (*Vice-President*), E. Oram (*Hon. Secretary*), R. H. Cricks (*Secretary*), Miss S. M. Barlow (*Assistant Secretary*).

Elections.—The following were elected :

Norman Sydney Giles (Student), Kay Film Printing Co., Ltd.
Sambhu Singh (Member), Motion Picture Engineer, India.
James William Hissey (Member), G.B. Film Library.
Vaclom Vich (Member), British Lion.
Irene Wilson (Member), Pathé Pictures, Ltd.
Roland Henry Kemp (Associate), S. Presbury & Co., Ltd.
Donald James Ramsey (Associate), Studio Film Laboratories, Ltd.
Jack Ryder Greenwood (Associate), Technique Film Productions.
Stanley William Simmons (Associate), Dekko Cameras, Ltd.
David Blythe Foster (Member), Delanium, Ltd.
Harold Morton Spencer (Member), Palace & Derby Castle Co., Ltd., Douglas, I.o.M.
Derek William Blackwell (Associate), Cinetechnic, Ltd.
Kenneth James Lowrey (Student), RCA Photophone, Ltd.
Robert Alfred Allman (Associate), Warner Bros. & First National Productions, Ltd.

Transfer.—The following was transferred from Associateship to Membership :

Stanley Clinton.

Death.—The death of Mr. William McInally was noted with regret.

Resignations.—The resignations of the following were accepted with regret :

Arthur Henry Page. James Greenoff.

Non-Enrolment in the Society.—It was reported that the undermentioned had failed to complete the necessary transfer form in compliance with Article 12 and their names were therefore erased from the Register :

Members : Messrs. K. M. Chirgwin, J. W. Cotter, J. H. Dawson, M. Gray, H. Grynszpan, R. Harris, R. J. Horton, D. A. Huish, B. Lotto, J. Mitchell, A. B. Richmond, J. Rix, W. Spencer, F. J. Standerwick, R. L. Standerwick, J. H. A. Whitehouse, J. Whitnall.

Associates : Messrs. C. W. Austin, K. C. Barker, H. Cartwright, D. Clifford, T. R. Cowley, A. Davis, W. C. Emery, N. C. Evans, L. G. Farnell, R. W. Hards, M. K. Hankinson, F. Herman, H. P. Hess, J. Hood, E. Humphriss, G. J. Johnston, P. L. Kendrick, B. Knott, J. J. Lawrence, A. H. Luff, C. Mepham, J. D. Millington, N. H. Pearce, J. L. Philip, G. A. Price, A. E. Rossiter, C. H. Schofield, L. Slow, B. H. Stephens, V. O. Stubbs, A. D. Surrey, C. R. Tasto, F. J. Taylor, W. Tigg, J. L. V. Woodiwiss, T. Wynne.

ORDINARY MEETING

The first Ordinary Meeting of the incorporated Society was held on May 14th, 1947, at Film House, Wardour Street, W.1. The President, Mr. I. D. Wratten, was in the chair.

Minutes

The minutes of the Annual General Meeting of April 10th, 1946, and of the Special General Meeting of July 26th, 1946, were read by the Hon. Secretary, Mr. E. Oram, and were agreed.

Hon. Secretary's Report

The Hon. Secretary, Mr. E. Oram, submitted his report as follows :

Membership.—As I have previously pointed out in my reports, it is to a large extent the ordinary membership which is the measure of success of a Society such as ours. Appreciating this, our Membership Committee has been strengthened and has been doing good work in enrolling members of the type which the Society requires. It is rather invidious to refer to any particular member of the Committee, but I feel I must stress once again the valuable work which Mr. Rex Hartley has contributed and which is reflected in the following figures :

Members : total 448.	Increase over 1946—131.
Associates : total 386.	Increase over 1946—45.
Students : total 67.	Increase over 1946—18.

These figures show a net increase of 194 and the total of the present membership is 901. These figures relate to December 31st last, since when, of course, we have received a number of new members.

Education.—One of the first objects for which the Society is established is to encourage and further the scientific and technical aspects of British kinematography and to encourage the study of kinematography in all its branches. The Council have therefore always felt they have justification for expending the major portion of their energy and expenditure on educational programmes which, of course, include our monthly meetings.

Discussions have taken place in co-operation with the Cinematograph Exhibitors' Association, and the Society is also represented at discussions on the British Film Industry Apprenticeship and Training Council.

The two-year Course at the Polytechnic has been maintained and it is interesting to note that in the present term 83% of the students are ex-Service men.

General Meetings.—The general meetings of the Society are a definite contribution to our educational programme, and as it will be appreciated by reference to the 1946/47 provisional programme supplied to all members, we have carried through an unprecedented number of lectures and maintained a high standard. Every endeavour has been made to cover all activities of the Society in the 31 meetings held in London and the 9 in Manchester and 8 in Newcastle. These meetings have included joint meetings with the Royal Photographic Society and the Association of Cine-Technicians, as well as the Television Society.

Divisions.—As will be seen by reference to the lecture programmes, the three Divisions, namely Theatre Division, Sub-Standard Division, and Film Production Division, have increased their activities and considerably strengthened their interests. A great deal of attention has been given and must be given by the Council to the development of these Divisions. Similarly, consideration is being given to the consolidation and expansion of the Provincial Branches, having regard to the extent to which these are interested in the Divisions, particularly the Theatre Division and Sub-Standard Division.

Fellowship.—In accordance with our new Constitution 15 Fellows were elected by ballot of the Members, and these elected Fellows have constituted a Committee to prepare regulations for the subsequent conferment of the Fellowship and Hon. Fellowship. After much deliberation the final proposals are nearing completion.

Patron Members.—It gives me much pleasure to record again our appreciation of our Patron Members' generous support. All our original Patron Members have continued their subscriptions, and in addition we have had a steady increase in membership.

I am confident that now that we have a definite programme and policy of education and advancement of the Society we can look forward to still further support in this direction.

Standardisation.—Although work has been resumed in connection with the British Standards Institution, progress has not been as rapid as I would have wished, due to the heavy load on the British Standards Institution organisation after the return to peace. A great deal of work has been done in reviewing existing standards and proposed American standards, and as a result a number of publications should shortly be forthcoming.

The Committee dealing with Screen Brightness has given a considerable amount of time to this subject, and the Institution has published an interim recommendation.

Library.—As Members know, the Library is now open every day, and each Monday evening until 8 p.m. A useful and valuable collection has been compiled, but we are still looking forward to receiving contributions of technical books, journals, etc.

Journal.—You will I am sure all agree that the high standard of our publication has been maintained and will be glad to know that schemes have been approved for more frequent publication, to start in July next.

Hon. Treasurer's Report

The Hon. Treasurer, Mr. P. H. Bastie, submitted the accounts for the year 1946, which he explained were, in accordance with the requirements of the Board of Trade, shown in two sections, the first half those of the unregistered Society and the second half after the adoption of the new constitution.

For the first period, subscriptions totalled £468 7s. 8d., and for the second period £599 5s. 6d., altogether an increase of £443 0s. 5d. over the previous year. Entrance fees, at £149 12s. 6d. and £221 10s. respectively, were £24 12s. 6d. higher than the previous year. Patron members' subscriptions, at £590 17s. and £257 3s. for the respective half-years were nearly double the figures of the previous year.

Expenditure had also much increased, and for the first half-year the accounts showed a surplus of £60 6s. 3d., while for the second half-year there was a deficit of £94 14s.

On the proposal of Mr. C. E. W. Crowhurst, seconded by Mr. F. Bush, the adoption of the Hon. Secretary's and Hon. Treasurer's reports and accounts was carried unanimously.

Annual Election

The President reported that the four officers of the Society had been re-elected unopposed. He also reported that Messrs. Norman Leevers and A. H. C. Rouse had been appointed scrutineers in the election of Council members, and called upon them to make their report.

Mr. Leevers reported that Messrs. C. H. Champion and Baynham Honri had received the highest number of votes. The President declared them duly elected.

Appointment of Auditor

On the proposal of Mr. C. W. Perry, the appointment of Mr. J. Foster, Incorporated Accountant, as Auditor was agreed unanimoulsy.

Votes of Thanks

The President moved votes of thanks to the scrutineers ; to the G.B. Picture Corporation for the use of the theatre, and to Mr. J. S. Abbott and his staff for their services ; to the Patron Members ; to the Trade Press for reports of meetings ; to the *Journal* advertisers ; and to all members who served on committees. The motions were carried by acclamation.

The President also expressed his appreciation of the services of the staff of the Society.

On the proposal of Mr. G. Parr, a vote of thanks to the Officers and Council was carried.

Physical Society Exhibition

Major C. H. Bell referred to the Society's exhibit at the Physical Society Exhibition. Although this did not fall within the year under discussion he moved a vote of thanks to Mr. W. Buckstone for his services; this was carried by acclamation. Mr. Buckstone asked that the names of Messrs. Norman Leevers, George A. Jones, and H. S. Hind be coupled with this motion.

Reports of the Annual General Meetings of the three Divisions are unavoidably held over

CARRIAGE OF FILMS ON LONDON VEHICLES

In June, 1946, the Ministry of Transport circulated draft By-law 18 of the London Passenger Transport Board, which would have had the effect of prohibiting the carriage of films, whether inflammable or non-inflammable, on the Board's railways. Representations were made by this Society, the Royal Photographic Society, and the Scientific Film Association, asking for exemption from this regulation of non-inflammable films.

As a result of these representations, the wording of the By-law has now been modified, the relevant portion now reading as follows :

" No person shall take into, or place in or upon, or cause to be taken into or placed in or upon any lift or vehicle, or elsewhere upon the Railway . . . . any cinematograph film . . . . Provided that nothing in this By-law shall apply to . . . . sub-standard film (16 mm. wide or less) formed on a cellulose acetate base, that is, so-called ' safety,' ' slow-burning,' or similar types . ."

The Society has accepted this revised wording, which it should be noted still prohibits the carriage of inflammable films upon the Board's vehicles.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of the Journal.

S. A. Cook has joined R. P. Pullin, Ltd., optical manufacturers.

B. J. Edwards, of Pye Radio, has been responsible for the research work connected with the recent demonstration at the Nettlefold Studios of a television monitoring system.

G. S. Moore is now technical manager of Ilford, Ltd., film sales, in place of—

J. W. W. Smith, who has been transferred to the photo-engraving section.

WILLIAM MACINALLY

Died May 16th, 1947

A Scot, Mr. Macinally was a very able engineer, holding both electrical and mechanical qualifications. He was for seventeen years chief engineer to Associated British Cinemas, Ltd.

BRITISH KINEMATOGRAPHY

The Journal of the British Kinematograph Society

VOLUME ELEVEN, No. 2. AUGUST, 1947

THE CARBON ARC: ITS CHARACTERISTICS AND PROPERTIES.

F. S. Hawkins, Ph.D., A.R.I.C. (Member)*

Read to the British Kinematograph Society on October 9th, 1946

THE formation of an electric arc between two pieces of well burnt charcoal was one of the earliest discoveries in the field of electrical research, for it was in 1809 that Sir Humphrey Davy, with the aid of a new and powerful battery, was able to demonstrate the phenomenon to the audience at a lecture in the Royal Institution. Most people credit him with the discovery of the electric arc, although there are prior claimants who have some grounds for claiming to have made the discovery during the previous five years.[1] Many people at that time were generating electric sparks, there is perhaps some doubt as to when these sparks first became arcs, but there is no doubt that we owe the first clear description and demonstration of the carbon arc to Sir Humphrey Davy.

In view of the early date of its discovery, it would be reasonable to suppose that the carbon arc would have been the subject of many researches, and that by now there would exist a considerable amount of knowledge concerning both the fundamentals and details of its operation. Such a supposition is correct; many researches have been made and much is known, but, nevertheless, it must be stressed that much still remains to be discovered about the complex phenomena that occur in even the simpler types of arc, such as one in which both positive and negative consist of a solid rod of pure carbon.

Many methods of investigation, chemical, electrical and physical, have been used to reveal the main characteristics of an arc, and each has added to our knowledge of the arc's operation. Some of the salient facts that have been revealed by these experiments can be demonstrated by a study of the striking of an arc and of the conditions required for its maintenance.

2. Striking and Maintaining an Arc

It is a well known fact that if two carbons are separated by a small air gap and are suitably connected to an electric supply, nothing happens when the supply is switched on, no arc is established. It can therefore be concluded that the presence of a potential gradient between the two carbons is in itself insufficient to start an arc. On the other hand, if the arc is established by the

* Research Laboratories of the General Electric Company, Limited, Wembley, England.

usual method of allowing the carbons to touch, and then separating them by a small distance, the current can be completely interrupted for a period of time, but provided that the interruption is of brief duration, not longer than about 1.25 seconds, the arc is re-formed and continues to burn as if nothing had happened as soon as the circuit is restored and the potential gradient is re-established. The essential difference is that the carbons and the arc gap are now hot and so the conclusion may be drawn that an arc can be established when the electrodes and gap are hot as soon as an adequate potential gradient comes into existence. If, however, they are not at an elevated temperature, then no arc results when the circuit is switched on.

This may be demonstrated experimentally by striking an arc, and as soon as it is established, switching it off, at first for short periods of only a fraction of a second's duration, and then for longer and longer periods, until finally the time is reached when the interval has been long enough for appreciable cooling to have occurred, and then restoring the circuit no longer restrikes the arc.

A convenient circuit for demonstrating this effect is shown in Fig. 1 ; the arc circuit is opened by a high speed contactor which remains closed until the push button controlling it is pressed.

3. The Functions of each Electrode

The above experiment shows that the arc is formed instantly if the current is switched on when both the electrodes and the arc gap are hot, but does not

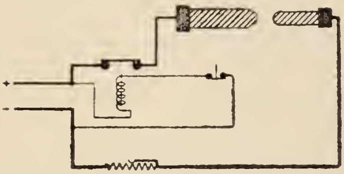

Fig. 1. Circuit for Demonstration of De-ionisation time of Carbon Arc

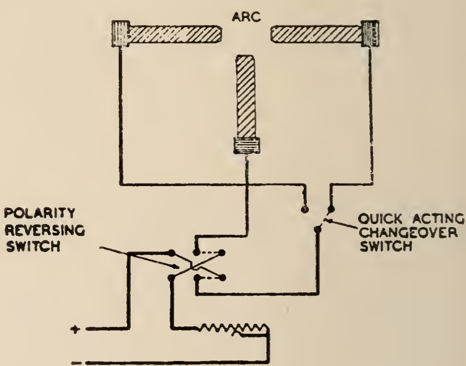

Fig. 2. Circuit for Transference of Arc to Cold Electrode

show whether it is necessary to have both electrodes hot, or whether the arc is formed if only one of the carbons is sufficiently heated. It can be shown in the following way that it is necessary only to have the negative hot. An arc lamp having three electrodes, two horizontal and one vertical, is connected as shown in Fig. 2. It is supplied with direct current through a ballast resistance, a reversing switch is fitted to make the vertical electrode either positive or negative at will, and a quick acting single pole changeover switch enables either of the horizontal electrodes to be connected to the other side of the supply. The arc is struck between one of the horizontal electrodes and the vertical electrode, and by means of the changeover switch the potential is removed from the hot horizontal electrode and applied to the other horizontal electrode, which is cold.

If the horizontal electrodes are made positive, then it is found that operation of the changeover switch causes the arc to be transferred from the hot electrode to the cold electrode with ease, it is interrupted for a fraction of a second as the switch operates, but re-establishes itself as soon as the volts are applied to the cold electrode. If, however, the horizontal electrodes are made negative,

the operation of the changeover switch does not cause the arc to transfer to the cold electrode, it causes only extinction of the arc.

4. High-speed Film of the Striking of an Arc

This experiment suggests that an early and essential step in the striking of an arc is the formation of a hot spot on the end of the negative.

A high speed film has been taken of the striking of an arc, and the details it shows support this view. The film is one of a double negative studio arc[2] being struck by an automatic striker in which a striking carbon connected to the positive side of the supply normally rests against only one of the negatives. On switching on, it is pulled away from the negative by an electromagnet, and initiates an arc between the side of the negative and the striker carbon. As the latter is pulled farther and farther away from the negative, the discharge transfers itself to the positive carbon and at the same time runs along to the tip of the negative, forming a hot spot in the usual place. The film shows that from now onward, this hot spot is stable, the arc stream steadily emanates from it, although it wanders about all over the face of the positive. Quite soon after the first negative hot spot has been established, in fact as soon as the arc stream, in its wanderings over the face of the positive, touches the other negative, the second negative hot spot forms, and remains stable. Finally the arc spreads over the whole of the face of the positive and becomes fully established.

These experiments demonstrate that the initiation of the arc cannot occur until the negative is made sufficiently hot, in fact, it can be shown that the function of the hot negative is to act as a thermionic emitter of electrons, just like the filament of a valve.

5. Striking the Arc by Ionisation

There is another method of striking the arc which throws light upon its mechanism, for it does not require either the negative or the positive to be heated as in the previous experiments. This is to strike the arc by ionising the gases in the gap between the electrodes. A convenient method of accomplishing this ionisation is to pass the flame of another arc, powered by an entirely independent supply, across the gap between two carbons ; if a suitable supply has been switched on to these carbons an arc is immediately established between them. It can be shown that such a momentary passage of the igniting arc across the electrodes of the main arc does not raise their temperature by passing it through the main arc without the power being switched on to the latter. The main arc electrodes are not even red hot immediately after this has been done, but if it is done when the power is switched on then the potential gradient between the main electrodes causes the positive ions in the flame of the igniter arc to travel to the main negative and raise the temperature of its surface by bombarding it until thermionic emission is established and the main arc strikes.

6. The Constitution of the Arc

Experiments such as these lead to the picture of an arc divided in three parts : the negative tip, the arc stream, and the positive crater, each with its own separate function. That of the negative tip is to be heated to a high temperature and emit thermionically a stream of electrons. These are caused by the potential gradient to travel towards the positive ; they collide with the gas molecules in the arc stream and ionise them, splitting them into positive ions and more electrons. The positive ions travel towards the negative, and when they reach it they bombard it and so maintain it at a

temperature high enough to keep up its thermionic emission. The electrons travel towards the positive and bombard it with the liberation of a comparatively large amount of energy. What happens as a result of their bombardment depends upon the material from which the anode is made.

7. The Operation of the Anode

If the anode is a solid stick of carbon its temperature will be raised to the volatilisation point of carbon, approximately 3,800° K., thereby forming the familiar highly incandescent crater of the low-intensity arc. If it is metal it will probably be heated to its melting point, an effect which is made use of in arc welding processes. If, however, the anode is made of something that can absorb the energy liberated without substantial rise in temperature, it will remain cool. An example of such a material is an aqueous solution of any chemical, *e.g.*, caustic soda, sulphuric acid, calcium chloride, which has a sufficiently low electrical resistance to allow the arc current to flow readily through it. An arc can be struck and maintained between a negative carbon and such a solution in exactly the same way as between a negative and positive carbon, as can be demonstrated by the apparatus shown in Fig. 3. It consists of a porcelain dish containing the solution, a metal plate placed flat upon the bottom of the dish and a rod of carbon connected to the plate and projecting from the solution. The rod, plate, and solution are connected to the positive side of the supply, the negative side is connected to a carbon rod in an insulated holder which can be held in the experimenter's hand. An arc can then be struck between the negative carbon and the solution by dipping it into the liquid and withdrawing it a few millimetres from its surface. If, however, the polarity is reversed, it is impossible to strike an arc between the liquid and the carbon rod, the liquid does not act as a thermionic emitter, but a normal arc can be struck between the pillar of carbon projecting from the liquid and the electrode held in the hand, for the arc forms a normal thermionically emitting hot spot on its surface.

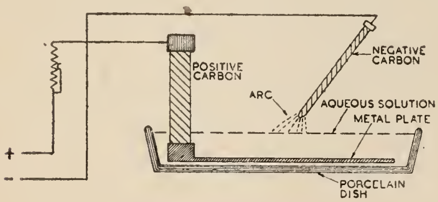

Fig. 3. Diagram for Using an Aqueous Solution as Anode

8. Anodes for Illuminating Arcs

Experiments such as these show that the anode of an arc of this type can be made of a large variety of materials, and it is the anode that is of great practical interest in illuminating arcs, for it is the effective light source. For this reason it is made of a refractory material which can be raised to a high temperature and so act as an emitter of light. In the case of the low-intensity arc the refractory material is a stick of carbon, which is raised by the energy liberated at the anode to its sublimation temperature of approximately 3,800° K. The high-intensity arc is more complicated, for in this case the positive carbon has a large core containing a high percentage of rare earth compounds. The latter are volatilised by the heat generated at the anode and a comparatively deep crater is formed. The negative is arranged so that the arc stream emanating from its tip hinders the escape of vapour from the positive crater, the vapours contained in the crater by this process are heated to an extremely high temperature and constitute a bright and highly luminous light source.

9. Energy dissipated in the Arc

The emission of a large amount of light from the positive crater of these arcs suggests that a large proportion of the energy absorbed by the arc will be dissipated here. Many experiments have been made during the last 40 years by different workers to ascertain how much of the energy input is dissipated at the positive crater, and how much in other parts of the arc. It has proved difficult to obtain reliable results, but the more recent measurements have shown fairly close agreement. The following values for a 150 ampère 11.25 kW. H.I. arc may be taken as typical :

From positive carbon to front of positive crater	5.25 kW
From front of crater, through flames to negative tip	4.5 kW
Negative tip to negative carbon	1.5 kW
Total	11.25 kW

Figures such as these suggest that the amount of energy dissipated may be an important factor in determining the nature of the phenomena occurring in the various parts of the arc, although there must be other factors such as the chemical composition of the carbons which have a very large influence on the behaviour of the arc. For example, a high intensity arc will be a very indifferent light source if the rare earth compounds in the core are replaced by others which do not form a luminous vapour. Given, however, carbons of normal composition, the parallelism traced in the previous paragraphs of this paper between energy expenditure and emission of light suggests that the positive crater happens to be the light source because the bulk of the energy is released there, and not only because it happens to be of positive polarity. If this is the case, and if we can by a suitable experiment separate the polarity from the energy dissipation, then we can show which of these two phenomena is the controlling factor in the formation of a crater and the emission of light from this crater.

In order that the effect of polarity alone can be isolated it is necessary to burn an arc in which the two carbons are of the same composition, so that differences in composition will not produce a misleading effect, and in which the energy dissipation at each electrode is the same.

10. The A.C. Arc

The A.C. arc between, for example, coppered cerium-cored carbons comes near to fulfilling these conditions, in that the carbons are the same, and the average energy dissipated at each electrode is the same, although the instantaneous values of the rate of energy dissipation will not be expected to be the same for both positive and negative polarity. Nevertheless, this arc was thought worthy of study in spite of this departure from the rigid requirements, to see whether it gave a clue to the effect of polarity.

Three high-speed films were taken at about 3,000 frames per second of such an arc, one film being fully exposed, so that the details of the carbons and the less bright portions of the arc could be observed, the others being taken with shorter exposures, thereby revealing the detail of the brighter portions of the arc. These films show that a bright flame of luminous vapour is formed between the electrodes, rising to a maximum and then falling once every half cycle, irrespective of which carbon is positive. A selection of prints of single frames of film from one cycle is given in Figs. 4*a*, *b*, *c*, *d*, *e*, *f*. In Fig. 4*a* the luminous flame is at the peak of its intensity, in 4*b* it has decreased in size and intensity as the arc current falls off, Fig. 4*c* was taken after the arc had passed through its minimum luminosity and illustrates a point that is quite striking when the film is projected, namely the bulging of the flame below the

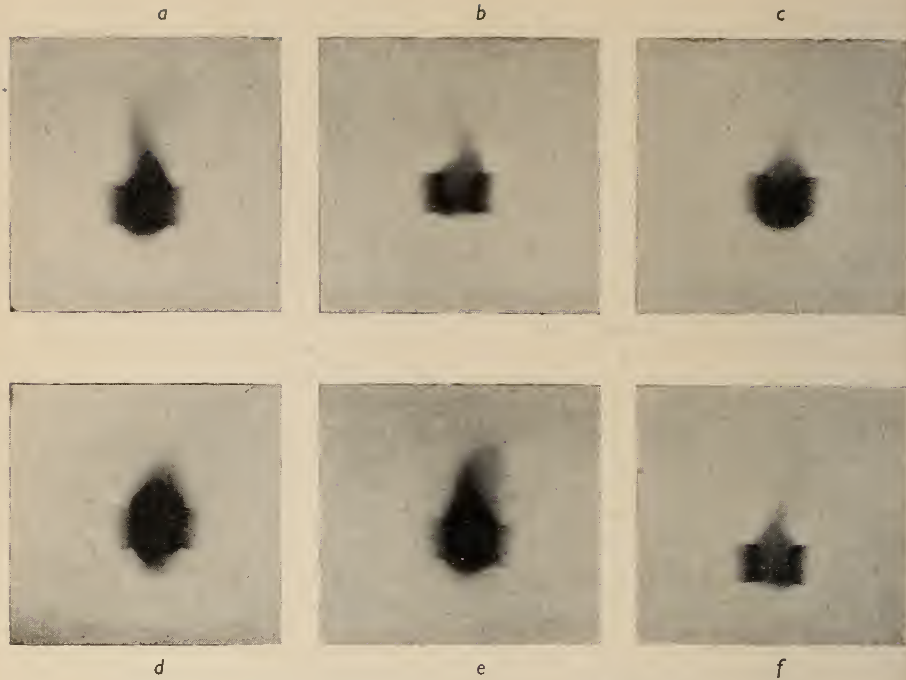

Fig. 4. Frames from High-Speed Film of A.C. Arc (3,000 frames per second)

electrodes at the beginning of each half-cycle before it develops fully above them. In Fig. 4*d* the volume of the flame has increased, and in 4*e* it reaches a maximum, falling off again in 4*f*. Figs. 4*e* and *f* correspond to 4*a* and b, but show the appearance of the arc after the lapse of half a cycle.

The first film also shows that the tail of this flame changes its direction every half cycle, its position depends upon the polarity of the electrodes (*see* Fig. 4*a*, *b* and *e*, *f*) ; by analogy with the direct current arc one would expect it to point away from the negative. The second film shows one interesting feature and that is a bright tongue of flame which arises from each electrode, whether positive or negative, every half cycle (*see* Fig. 5*a*). These tongues of flame appear to correspond to the overspill from the crater of the positive of a D.C. arc and suggest that the comparatively shallow crater of the A.C. arc contains luminous gases similar to those contained in the deeper D.C. positive crater. This is what would be expected from the positive electrode in any given cycle of the A.C. arc, but it can be seen from this film that it also occurs at the negative electrode ; for instead of only one carbon showing a bright tongue of flame, both show it during each half cycle. There is a difference between the two tongues in that the negative tongue constricts when the peak current is flowing in a manner reminiscent of the constriction of the negative flame of a D.C. arc that first appears as the current is raised to about 80 amps.

It is difficult to illustrate this point by the reproduction of single frames of film ; some indication is given by Fig. 5*b*, in which the left-hand side flame is constricted. The effect is clearly visible when the moving film is projected, but can best be seen by direct vision of the arc with the aid of a stroboscope to arrest the motion of the arc flames.

The third section of the film is exposed to show only the brightest portions of the arc ; it shows quite clearly the simultaneous appearance of the bright tongues of flame at both electrodes, it also shows that they are of quite similar

a b c

Fig. 5. Frames from High-Speed Film of A.C. Arc showing Negative Flame

in luminosity, but differ somewhat in size, the positive being the larger (Fig. 5*c*).

11. Possible relation between Crater Formation and Energy Dissipation

These experiments suggest, but do not prove, that the formation and shape of a crater is largely dependant upon the energy expended at the surface of the crater, more dependant upon energy than upon polarity. Other experiments have been made in which carbons have been burnt both as positives and as negatives, and if the current passed through them when they are burnt as negatives is about six or seven times as great as when they are burnt as positives, very similar craters are formed. Examples are shown in Figs. 6 and 7. In Fig. 6 the carbon was burnt as a positive at 12–13 ampères, as a negative after copper plating, at 85–90 ampères, the silhouettes show the outlines of the tip and crater to be very similar. Similarly, in Fig. 7 the carbon was burnt as a positive at 200 ampères, as a negative without a copper coat at 1,200 ampères, and again the crater dimensions are similar. In each case the left hand side photograph was taken after the carbon had been burnt as a positive.

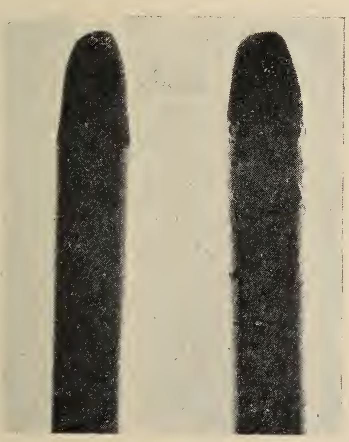

Fig. 6. Carbon burnt first as Positive at 12/13 amps (left) and subsequently as Negative at 85/90 amps

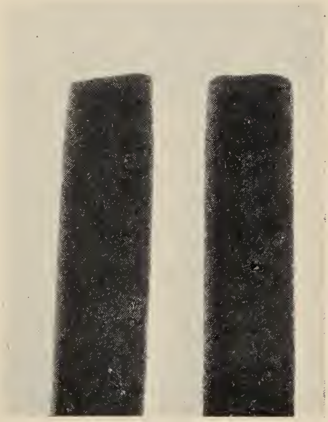

Fig. 7. Carbon burnt first as Positive at 200 amps and subsequently as Negative at 1,200 amps

Such experiments, while they suggest that crater formation depends upon energy dissipation rather than polarity, are not in themselves sufficient to establish the fact. Much more experimental work is required, particularly on the measurement of the energy released in the various part of the arc and its relation to arc current, before it can be shown with any degree of exactness

what relationship there is between these two quantities ; at present there are only a few pointers which suggest that the energy dissipation and not the polarity is the controlling factor.

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DISCUSSION

Mr. R. H. Cricks : A number of years ago I made some experiments on magnetic control of arcs and found it was possible to increase the efficiency of an arc by depressing the flames into the crater. Have you done any work on this subject ?

The Author : Magnetic control is a subject for a lecture in itself, but it can be said that the primary function of the magnet is to twist the arc stream to an appropriate angle. It has been well established that if you can burn H.I. carbons and choose the angle for the negative so that you get the optimum compression of the vapours in the positive crater purely by the setting of the negative angle, then it is difficult to secure improvement by the use of a magnet. But it is not always possible so to set the negative, for instance, optical reasons may prevent it being done. What you can do under those circumstances is to put the negative at a different angle, and then magnetically bend the negative stream so that it enters the positive stream at the optimum angle.

Mr. S. A. Stevens : What happens when you replace the negative of the ordinary H.I. arc with a negative that also has a cerium loading ? Why is there such a difference in voltage as one gradually changes a D.C. arc into an A.C. arc ? If you take a D.C. arc with a voltage of about 40, and then superimpose A.C. upon it, the arc voltage steadily falls.

The Author : Dealing with the second point first, as it seems you have done the experiments, when the arc voltage is gradually lowered by the A.C., do you at the same time get a corresponding decrease in the depth of positive crater ? It is usually thought that much of the reduced arc voltage in the A.C. arc comes from a reduction in crater depth.

With regard to the first point, of putting a negative in place of the positive, what happens is complicated by the fact that it is extremely difficult with the core of positive composition to keep the negative hot-spot stable ; it wanders about.

Mr. W. Dolbear : Do you favour automatic striking ?

The Author : With proper automatic striking there is no danger of throwing chips off the positive, as occurs in some forms of hand striking.

Mr. A. P. Castellain : Could Dr. Hawkins give us some information as to how he assesses the energy in the various parts of the arc ?

The Author : The basic method is to insert a probe in the arc, and with a known current flowing in the arc, measure the voltage between the probe and the positive electrode, under circumstances where the probe causes a minimum disturbance of the arc.

Mr. Cann : May I ask Dr. Hawkins whether an increased illumination would be gained by using different rare earths ?

The Author : In 1924 experiments were carried out in these laboratories with all the elements in the periodic table. There are none better than those used at present.

Mr. F. G. Gunn : Could you briefly review the advantage of using a double negative, 150 ampère arc lamp ?

The Author : They are two-fold. If you replace the single negative by two negatives, each of which carries half the current, then the bubbling and frying noise is reduced, and the arc voltage changes from 65 to 48 or 49 v. As a result of this fall in voltage, you can run two of these lamps in series on the 115 v. studio supply.

Mr. F. G. Gunn : Do you reduce the amount of energy dissipated from the positive crater ?

The Author : No, the drop in energy comes from a reduction in the arc length.

Mr. J. New : Is there any limit to the number of negatives you could introduce ?

The Author : We have tried three, but we found it difficult to effect any further gain.

Mr. S. A. Stevens : I take it it is quite unnecessary to use two negatives with any advantage in a projection type of arc ?

The Author : That depends on what size of positive the kinema projectionist wants to use. There is nothing to be gained by using two negatives on small diameter positives. On the other hand, if you come to the 13.6 mm. positive carbons, then quite an appreciable saving in power can be made.

VISIT TO G.E.C. RESEARCH LABORATORIES

MEMBERS of the B.K.S. visited the G.E.C. Research Laboratories, Wembley, on October 9th, 1946, and made a stimulating three-hours tour of the enormous building. A paper on research work in connection with arc lamps was read by F. S. Hawkins, Ph.D., A.R.I.C., reported on another page.

The first department visited was one where all restrictions on lighting and power consumption seemed to be defied : the section where specimens of all types of lamps undergo life tests. Among the hundreds of types of lamps, one particular novelty was of especial interest : a high-pressure mercury lamp which was burnt horizontally, the discharge being deflected off the glass bulb by means of a magnet.

An intermediate stage between the designing of a new lamp and its production in quantity is pre-production development. For this purpose special workshops are set aside, which were engaged on numerous types of lamps. Another feature of the laboratories which must be of great practical value is the locating of several small workshops at convenient points, where small mechanical jobs can be carried out at short notice.

Wire-drawing Dies

The G.E.C., owing to war conditions, was responsible for the creation of a new industry in this country : the manufacture of diamond dies, used for drawing fine wires, and previously manufactured chiefly in Holland. In this department, which is staffed almost exclusively by girls, the diamond is first ground on four faces ; a deft-fingered girl then mounts the diamond in a jeweller's lathe, and with a diamond chip centres it, just as a turner might centre a steel rod. From this centre a tiny steel needle coated with diamond dust drills a hole half-way through the stone, on a multi-spindle machine in which every few seconds the drill is automatically withdrawn and sharpened on a small grinding wheel. The diamond is then reversed and the opposite face countersunk to meet the drilled hole ; finally it is mounted in a steel die-holder.

Some idea of the delicacy of this work may be gained if it is mentioned that the smallest standard size of hole is .0004 ins ; in use the die wears larger, and the hole is then lapped out to the next size.

Testing Projection Carbons

Of chief interest to the projectionists among the visitors was the laboratory where the projection carbons are tested. Two types of apparatus are used, on one of which a Peerless arc was mounted, the light from which was thrown upon a projector gate, which formed the aperture of an integrating sphere, the photo-cell in which was connected to mirror galvanometers, enabling a constant reading of light output to be taken over a twenty-minute run.

On the adjacent stand was a Ross arc, upon which measurements of light distribution over the screen were being made. The light was focused upon the gate of a specially modified projector head, whose lens projected the beam upon a framework carrying nine photo-cells. Another device demonstrated enabled the brightness distribution over a positive crater to be read in the form of a curve on the screen of a cathode-ray tube ; the image of the crater was scanned and the output of the photo-cell fed to the Y plates of the tube, the X plates being connected to a time base. In this way curves showing the brightness distribution in slices of the crater are produced photographically.

Radar Research

Next, the visitors toured the laboratories devoted to the development of cathode-ray tubes. Tubes of all sizes, from a tiny $1\frac{1}{2}$ in. tube used for instrument work, to a 12 in. television tube, were explained in detail. One particular 6 in. tube had been specially developed for the R.A.F. for use in Radar, its function being to reproduce the terrain underneath the aircraft in the form of a map. An experimental Skiatron tube was also shown.

By means of three-stage mercury pumps, the pressure in finished tubes is brought down to the order of 10^{-7} cm. of mercury, and for research purposes a demountable system is used, in which the electron gun under test may be mounted in a tube sealed only by a ground-glass surface and oil, and exhausted within a few minutes.

Time did not permit of a lengthy visit to the valve laboratories. However, the visitors saw the laboratory in which the Magnetron—the valve that made centimetric radar possible—was developed ; here at one time five hundred such valves were being turned out weekly. One laboratory is concerned solely with ultra-short wave research. In an interesting experiment a tube containing mercury vapour was held close by a generator of such waves of 10 cm. wavelength, and the glow produced in the tube was seen to have black bars at 10 cm. intervals, illustrating the formation of standing waves.

Illumination Measurements

In the illumination section a particularly interesting piece of newly-developed apparatus was an instrument for measuring brightness levels of a scene. The image is scanned by means of a high-speed disc, and the light falls upon a photo-cell which produces a brightness curve upon the screen of a cathode-ray tube. The instrument, which is a development in a more sensitive form of the apparatus for measuring the brightness distribution of the carbon-arc crater, could be adapted for use as a precision exposure meter merely by calibrating the screen to suit the particular emulsion.

Two devices were used to test prismatic lenses, such as are used for studio lamps. In a profile projector the section of the lens was magnified about fifteen times for exact measurement. In another device, a narrow beam of light was moved across the section of the lens, and the accuracy with which the lens produced a parallel beam could be studied minutely.

In an adjoining room was a remarkable display of fluorescent signs, whose brilliant colours were produced by the " black light " of ultra-violet mercury lamps. As soon as lighting restrictions are lifted, the striking and beautiful effects so produced will undoubtedly find a wide use in the kinema.

This completed the tour of the Laboratories ; the visitors next repaired to the staff canteen, and after tea retraced their way along the lengthy corridors to the kinema laboratory where a particularly interesting paper was delivered by Dr. Hawkins, describing certain fundamental research into the nature of the carbon arc. The lecture was concluded by a demonstration to the audience of the light and noise of an enormous 1,200 amp. searchlight arc, which was burning as a negative the same carbon which previously had run as a positive at two hundred amps.

UNIT SPECIALISATION IN KINEMA EQUIPMENT

S. B. Harrison-Swingler (Member)*

Summary of Paper read to the B.K.S. Theatre Division on Sept. 22, 1946

THERE are now approximately 5,000 kinemas in this country, a large number of which seem to have been equipped without proper regard to the all-important question of obtaining the highest standard of results, economy of operating costs, and maintenance of efficiency. The last is of considerable importance.

The modern projection room demands the highest degree of co-ordination of all its equipment, and unless all items are carefully selected for unified operation, the best results are unattainable. One weak link in the chain will prevent perfect screen presentation, and lower the standard of efficiency.

Haphazard Choice of Equipment

Often the ordering of projector arc conversion apparatus, whether it be rectifier or motor-generator, was placed in the hands of a contractor who supplied what was thought to be adequate for the equipment which it had to feed. The variation in arc currents used, from low intensity at 25 ampères up to high intensity at 140 ampères, has resulted in arc conversion gear in many cases being totally unsuitable, inefficient and under- or over-loaded.

From the arc lamps available, one was chosen not because of its suitability for a theatre's requirements or its combination with other projection apparatus, but largely due to the selling effort of the equipment company's representative.

The projectors were in some cases even of different manufacture, and the objective lens invariably was acquired without full knowledge of its optical characteristics or efficiency in relation to the arc mirror or arc collecting medium. Largely, it is to be feared that, in those days, its *f* value was wrapped in mystery.

The screen itself was very rarely considered in relationship to the remainder of the projection technique.

It is obvious that with such a haphazard combination as described in the foregoing, maximum efficiency is not obtained. Furthermore, there is, as is well known, a gradual deterioration in screen illumination which is progressive, as mirrors, condensers and screen surface became affected.

Specialised design in Lighting Apparatus

While some manufacturers have produced a range of equipment needed completely to equip a projection room, not one has published specific information as to the technical data of each individual unit or what results can be obtained on the screen in actual illumination. Nor have any recommendations been made that optimum results can only be obtained by using any one of their components in conjunction with others of certain known characteristics.

To give specific instances, the maximum light emitted by a given carbon combination is attained when it is operated at the highest amperage without the core or shell breaking down.. Somewhere within its rating, certainly nearer the higher value, is the optimum operating condition, having due regard to crater brilliancy and economical performance. How then can the carbon manufacturer produce carbon combinations that will be adequate for a wide range of electrical and operational requirements ?

There are many types of apparatus for supplying current for arcs, but so far, of all those manufactured, only one, to my knowledge, has been exclusively

* Engineering Controller. Odeon Theatres Ltd

designed to give the utmost efficiency at a predetermined arc voltage and ampèrage to suit a particular type of lantern. Here again, if the rectifier manufacturers had specific data available, they could produce apparatus that would give optimum conditions at its most economical running cost.

Standardisation of Equipment

Obviously, if one equipment supplier were to plan all the components, each and every item would become an integral part, wide limits would be avoided, therefore efficiency must be increased. Equally if published data were available of all major components upon the market, an experienced theatre engineer could plan the projection apparatus as a whole, for maximum efficiency.

The recent world conflict has proved beyond question that scientific research has advanced phenomenally in a short period and the opportunity now becomes available to consider what steps may be taken towards the unification of equipment.

Firstly, establish at once a minimum standard of screen brightness.*

Secondly, determine screen widths on a scientific basis in accordance with auditoria size and maximum seating range.

Thirdly, when the first and second recommendations have been established, the equipment suppliers should produce electrical and picture projection apparatus in units and ranges that could be classified according to the output in lumens.

If these points were achieved, a theatre needing equipment to illuminate a screen of given size to the required standard would acquire from the range equipment which would be capable of producing this, with the knowledge that each and every item would be a harmonious combination of mechanical and optical apparatus, with an efficiency of the highest order.

Accuracy in Screen Illumination

The progressive deterioration of optical components and loss of reflectivity of the screen surface is considerable. It is imperative that this loss should be minimised by replacing or re-surfacing the screen and renewing the mirrors when the light, as the patron sees it, deteriorates. This should be a regular routine service item ; the alternative of increasing current to the carbons hould not be considered.

As the eye cannot easily detect a difference of up to 12½% increase or decrease in light, it becomes necessary to have tests made with an accurate measuring device, so that immediately the screen illumination drops below 20% of its original intensity, steps be taken to bring the light back to its original level. Such measuring device should record the screen illumination as the patron sees it and it should also have a response that would bear a reasonably close relationship to that of the human eye.

This paper has served merely as an introduction to the problems to be discussed in subsequent technical papers, to be delivered during the forthcoming session by manufacturers of the respective projection room requisites. In course of these papers, each manufacturer will enlarge upon the requirements of his own equipment, needed to adapt it to unified working with other components.

DISCUSSION

Mr. H. C. Stringer : The seating capacity of the majority of the kinemas in the United States is nothing like ours. They build kinemas with 400 or 500 seats, and obviously their screen size is smaller. That is why they seem to have a better standard of screen brightness than we have.

Mr. Perkins : A standard of sound level is needed as much as a standard of screen brightness.

Mr. W. F. Garling : It is easier to obtain the right level of brightness than the right standard of sound level as this is changing almost continuously.

* Since this paper was delivered, a draft British Standard has been circulated, specifying a brightness of 10^{+4}_{-1} foot lamberts.

ARC LAMP CONVERSION EQUIPMENT

J. C. Milne, A.M.I.E.E., M.Amer.I.E.E.*

Read to the B.K.S. Theatre Division on November 17, 1946

THE methods used in the kinema for converting alternating to direct current have varied very considerably during the course of years, from the early motor-generator sets to mercury-arc rectifiers, hot-cathode rectifiers and metal rectifiers.

Motor Generators

Nearly all kinemas until the 1930's were provided with motor-generator sets, one set being provided to give the D.C. supply for both arc lamps, spot-lights, etc. This generator set was arranged to have an output voltage of 100/110 volts and a ballast resistance was provided in each arc lamp or spot-lamp circuit to drop this voltage to 30/40 volts, for supply to the carbon arc itself.

In an endeavour to reduce the losses and increase the efficiency of the conversion equipment, the Electric Construction Company produced a number of compound wound motor-generator sets which were designed to have a no-load output of 100 volts, and a full load output of 40 volts, so that the use of ballast resistances could be avoided. A separate generator had to be employed for each arc, but the actual power consumption was reduced to half of what it was in the case of an orthodox installation

Mercury-Arc Rectifiers

The mercury-arc rectifier completely superseded the use of the motor-generator on A.C. mains, except in isolated cases, owing to the fact that it has a higher efficiency, is static, and requires little maintenance. It does not require foundations, and generally is far more adaptable for this type of duty. Ballast resistances were still employed to provide the necessary characteristics and arc stability, and the overall efficiency was low. In many instances, two rectifiers were arranged to run in parallel so that adequate stand-by equipment was available.

The majority of kinemas to-day are fitted with this type of equipment. It consists of three major parts :—

(*a*) A mains transformer.
(*b*) A rectifier bulb.
(*c*) A smoothing choke.

The alternating current from the supply is fed into the primary of a transformer, also fitted with various auxiliary windings for excitation of the rectifier bulb and for supplying power to the cooling fan, etc. The mercury arc rectifier bulb consists essentially of an evacuated glass chamber which is fabricated with special arms in which are situated graphite anodes, while at the base of the bulb is a pool of mercury, *see* Fig. 1. The anodes are made of pure graphite, and are connected through tungsten rods sealed in the glass chamber to form vacuum-tight joints and to allow the current to flow. It operates by virtue of the fact that the mercury emits electrons which constitute a current flow in one direction only ; thus each anode will carry current only while it is positive, and when it is negative the anode will be extinguished as no current can flow through the bulb in the reverse direction. The

*Chief Rectifier Engineer, Electric Construction Co., Ltd., Wolverhampton.

output is smoothed by a cathode smoothing choke to reduce the ripple and eliminate any hum which might be apparent in the arc. The rectifier bulb is generally provided with small excitation and starting electrodes which maintain ionisation of the mercury when current is not being taken from the main anodes, so that the bulb is always ready for instantaneous use.

Many mercury arc rectifiers have been operating for 10 and 20 years, with a life of well over 50,000 hours. They are extremely robust and once installed give very prolonged satisfactory service.

Hot-Cathode Rectifiers

In place of mercury arc rectifier bulbs, hot-cathode rectifier bulbs have been utilised, chiefly in smaller kinemas, owing to their low capital cost. Valves have been practically unobtainable in war time, and as they only have a strictly limited life it has been necessary in the majority of cases to convert the hot cathode rectifier equipments in use to either mercury arc or metal rectifier sets.

These valves are very similar in many respects to ordinary radio valves. The filament provides the thermionic electronic emission necessary for the operation of the valve, and this filament deteriorates with use and, therefore, manufacturers will not guarantee more than 1,000 hours life from this type of valve. Valves are each arranged for single-phase, half-wave rectification, a number of separate valves being employed for 3- or 6-phase rectification, three valves in the case of the 3-phase equipment and six valves in the case of a 6-phase equipment.

Development of Arc Lamps

During the last ten years there has been very considerable progress in the design of the carbon arc projection lamp which has helped considerably to increase both the efficiency of the lamp itself and the efficiency of the conversion.

In the early days arc lamps were for hand operation ; to ensure stable operation and to maintain the arc satisfactorily for some minutes before it was necessary to re-adjust, a D.C. supply voltage of 100 to 110 was selected, dropped to 40 volts by means of a ballast resistance, this providing a very stable form of supply, but very inefficient. The actual electrical consumption of the arc would be, for instance, 60 ampères at 40 volts, *i.e.*, 2.4 kW., and the output from the rectifier would be 6.6 kW., which, assuming an efficiency of 80% for the rectifier, gives a total of 8.25 kW. input to the rectifier, an overall efficiency of 29%.

The next development was the auto-feed arc, where the carbons were fed by a small electric motor connected across the arc, and fed in the carbons at a pre-determined and adjustable rate, so that the arc gap was maintained at a constant value. Therefore, we now have a carbon arc consuming 60 ampères at 40 volts, where the voltage and current are maintained by automatic mechanism, this arc being essentially stable in itself since it is continuously adjusted by the motor. Therefore, it is not necessary to have such a high no-load voltage, and rectifiers with an output of 80 volts to 90 volts were considered satisfactory for this purpose, ballast resistances again being used to reduce the voltage to that required by the arc.

Choke Control

The next step in the trend of development was to improve the efficiency of conversion and eliminate the losses in the ballast resistances. This led to the use of individual rectifiers for individual arcs. The reason for this will be obvious as the problem is further considered.

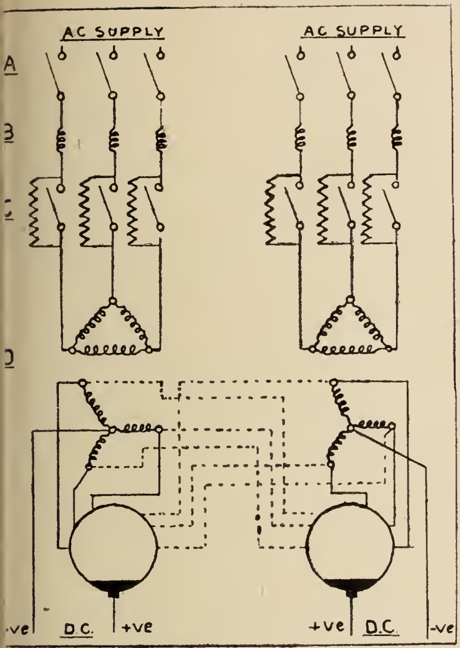

Fig. 1. Circuit of Twin-bulb 3-phase Choke-controlled Rectifier for supplying two Arcs. A—Start contactors ; B—Chokes ; C—Running-in Resistances and Contactors ; D—Main Transformers.

Fig. 2. "Nevelector" Single-phase Rectifier.

For the satisfactory operation of the arc itself, it is essential that the rectifier output should be provided with a tapering voltage characteristic, similar to that produced by a rectifier with the ballast resistance, and to do this, suitable chokes are connected in the A.C. supply mains so that as the current from the rectifier is increased, the voltage drop across these A.C. chokes increases and the necessary taper characteristics are provided. There is a considerable saving in efficiency, as ballast resistances are no longer necessary. As each rectifier has a taper characteristic, it is not possible to use one rectifier to give the necessary characteristics for several arcs, since very severe interference would be caused during the change-over, which is so undesirable. Thus for operating two arc lamps, it is necessary to provide two rectifiers each having a suitable output for each arc, the two rectifiers being carefully matched to ensure that the light from each arc is the same. This type of equipment is produced both in the metal and in the mercury-arc types, either of which is highly satisfactory, giving an overall efficiency of 50 to 70% depending entirely upon the individual construction and arc characteristics.

The main disadvantage of this type of equipment is that by adding chokes in the A.C. side of the equipment, the power factor is reduced, approximately proportionately to the amount of inductance added, and power factor improvement condensers are necessary to ensure that the power factor does not fall below .8. Adjustment of the arc voltage and current is provided for by means of tappings on the transformer or chokes, these tappings being adjusted by links or tapping switches

Rectifiers of this type are normally mounted remote from the operating box and provided with suitable contactors so that remote operating can be obtained by push buttons from the projector head. A suitable remote controlled push-button station complete with voltmeter and ammeter is provided on each arc lamp, these control stations being arranged with three push buttons: "start," "run" and "stop." In the "start" position the output of the rectifier is reduced to a pre-determined amount for running-in purposes. This can be done either by means of tappings on the choke or by means of a small resistance which is connected in the output of the rectifier, the latter method being more usual owing to its simplicity, and as the running-in resistances are only in circuit during starting purposes, its losses are of small consequence. (Fig. 1).

High Efficiency Rectifiers

A popular type of equipment is a twin-bulb mercury arc rectifier set where each bulb is provided with six anode arms, only three anode arms on each bulb being utilised for each arc. In the case of trouble being experienced with either half of the equipment, the second three arms on either bulb can be utilised for the other arc, so that the two arcs can run from one bulb if necessary. Thus stand-by equipment is provided and comes into operation merely by changing over a small single-pole switch. There is no interconnection between arcs and there is no need for the projectionist to take any special precautions during the changeover.

With this type of equipment the chief projectionist can set the arc voltage and arc current at which he requires the arcs to run, and then by means of the push-buttons on the projector these characteristics are immediately obtainable, so that the actual arc current and voltage is not subject to adjustment by unauthorised persons.

A similar type of equipment to the above is produced by the Hewittic Company and is called their "Econotrol" unit. This consists of a single or two bulb rectifier equipment employing anode chokes in the manner described above. In the two bulb equipment two or three arm bulbs are provided and in the case of trouble in one bulb a change-over switch can be switched over to switch both arcs on to one bulb, but it is essential for the projectionist to make a very quick change-over when using one bulb, as otherwise there will be interference between the two arcs. Switches for the control of arc voltage and current are arranged for mounting in the projection box, no contactors being provided for remote control.

High Reactance Type Equipment

A further development from the above is high-reactance transformers where, instead of using chokes to give the necessary output characteristics, the transformer itself is designed to give these characteristics by virtue of its inductance, and the arrangement of its primary and secondary coils. Many of these equipments have been supplied and have been very successful in operation, the elimination of the chokes, of course, increasing the efficiency still further and simplifying the equipment considerably.

Post-War Developments

There have been very appreciable post-war developments in kinema arc rectifiers. Single-phase types for use in operating boxes include the "Nevelector," produced by the Nevelin Electric Company (Fig. 2), and the "Uni-Arc" produced by the Hewittic Company.

Each equipment is a single-phase mercury-arc rectifier provided with the necessary A.C. chokes to give the output the characteristics required, and the necessary smoothing filters to smooth out the single-phase 100-cycle

ripple which is prominent on single-phase equipments. These equipments are entirely self-contained, and are provided with two tapping switches giving in all 12 variations of arc current and voltage, from 25 to 65 ampères. Meters are provided on the front of the equipment for indicating the output to the arc. The efficiency is from 60 to 70% under normal operating conditions.

One rectifier is required for each arc and for each spot lantern, so that in a normal projecting box with two arc lamps and one lantern, three of these units would be required, although two could be used, providing the operator planned his programme beforehand. As it is intended that these equipments should be connected from phase to neutral across the 3-phase supply and that they should be mounted in the operating box, there is some difficulty with regard to various regulations, since in some areas it is not permissible to have 230 volts in the box, while in other cases there is no objection. At the present time the Home Office are considering modifying these regulations so that a higher voltage can be arranged in the operating box, in which case there would be no objection from this source.

Owing to the fact that a single-phase supply is used, the power factor is about .5 and to increase this to .8, power factor correction will be required.

New Twin-Arc Equipment

An entirely new step in conversion equipment comprises a special 3/6-phase rectifier having one transformer and one rectifier bulb only, the rectifier transformer being provided with a dual output for supplying two arcs from one bulb without any interference whatever between the two arc supplies. This eliminates the use of chokes altogether, considerably simplifies the equipment, reduces the weight and dimensions very appreciably, and provides the operator with all he requires.

It is primarily intended that this should be situated out of the operating box and its control should normally be by means of push-buttons situated on the projector. Assuming, however, that the Home Office regulations will be modified as mentioned above, there is no objection at all to the equipment being in the operating box (Fig. 3).

Push-button stations are arranged on the projector head and have push buttons giving "start," "stop" and "run" positions, also voltmeter and ammeter indicating the arc consumption. Tapping switches are provided on the rectifier giving 16 positions of voltage and current output. The efficiency of this equipment is from 60 to 70% and the power factor .7 to .8 under normal working conditions without any power factor correction.

Metal Rectifiers

Metal rectifiers of the selenium-iron type are produced by the Westinghouse Company and by the Electric Construction Company. The standard equipment normally consists of two 3-phase rectifier units mounted in the one cubicle, forced ventilated, and arranged with the necessary chokes and condensers to provide the voltage characteristic required by kinema arcs. They are suitable for remote operation or for mounting in the projection box. The equipment is provided with contactors for remote operation, and control boxes giving "start," "stop" and "run" positions.

Metal rectifiers are manufactured in the form of metal plates, each plate being capable of rectifying up to a maximum of about 12 ampères per plate at a voltage of approximately 12 volts. These rectifier plates are connected in series and parallel as required, depending upon the voltage and current of the arc lamp.

Metal rectifier equipments give an efficiency from 60 to 75% when new, but this efficiency drops off as the equipment ages, so that in a matter of

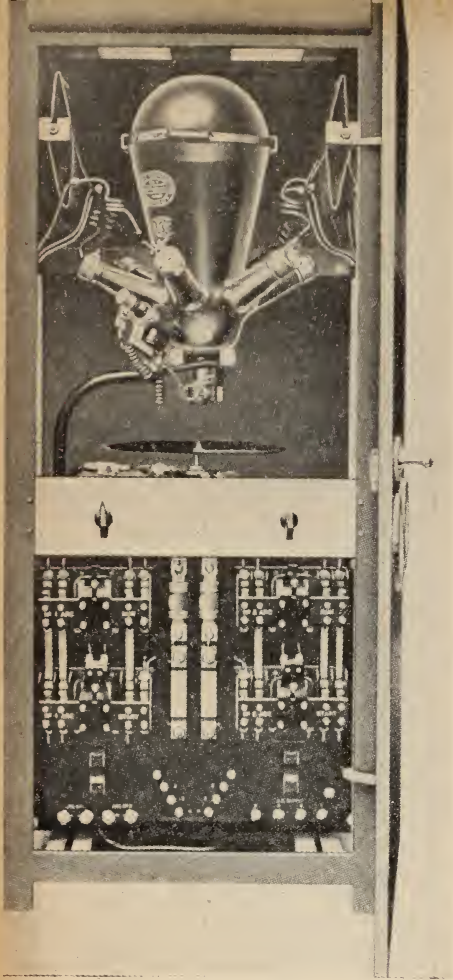

Fig. 3. E.C.C. "Ecwelite" High-efficiency type 3-phase Rectifier for supplying two Arcs and Lantern. Showing Contactors for Remote Control and Pre-selector Arc Volt and Current Switch.

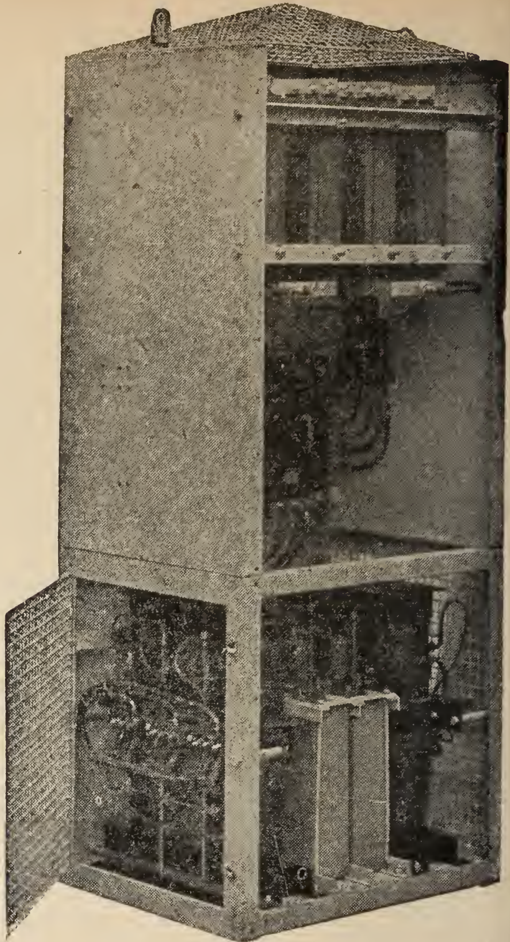

Fig. 4. Westinghouse Twin-Arc Metal Rectifier, with Resonance Control.

two years the efficiency will have dropped by approximately 10%. Tappings are provided to compensate for this ageing by all manufacturers and the tappings are provided also to vary the output to suit individual arc conditions.

It is the considered opinion of the author's company, as manufacturers of both mercury-arc and metal type rectifiers for kinema use, that mercury arc rectifiers are superior and give better service than metal rectifiers for kinema arc projection purposes. The ageing of metal rectifiers is quite appreciable, and the average life is considerably less than that of the mercury arc rectifier. In addition, the output from the metal rectifier equipment falls off from time to time and requires compensation by means of the adjusting tappings.

Opinions are often expressed that the rectifier with the maximum efficiency should be utilised for projection purposes. However, having obtained an efficiency of 65%, which with a normal 60 ampères arc represents a consumption of 3.7 kW per arc, the saving in power costs by increasing this efficiency even a further 5% or 10% is only a matter of a few hundred watts. Actually, having reached the efficiencies that we have to-day of 60% to 70%, a much more important requirement is the question of reliability and flexibility of operation.

Location of Rectifier

The next important point, is the question of whether the rectifier equipment should be situated in the operating box or whether it should be situated

out of the operating box and remotely controlled. The single-phase rectifier is arranged especially for fitting in the projection box at the side of the projection lamp, and this, of course, leads to some saving in initial cost, as no remote contactors or push buttons are required. Although there is no serious objection to this, the author suggests, after discussions with many projectionists and projection engineers, that as much equipment as possible should be eliminated from the operating box, and that the operation of the projection equipment should be made as simple and reliable as possible.

Thirdly, there is the question of single or 3-phase equipments. From the point of view of economy and reduced fundamental ripple, it has in the past been the tendency of all rectifier manufacturers to manufacture 3 or 6-phase rectifier equipments unless only a single-phase supply was available. There is a tendency now to use the small single-phase equipments, one for each arc, as this provides flexibility. Here, of course, the claim for single-phase is that it makes the equipment smaller and more economical to produce, while if the ripple is satisfactorily smoothed there is no detriment in using single-phase rectification for this purpose. The multi-phase rectifier has, however, obvious advantages.

Acknowledgments

In conclusion the author must thank the Electric Construction Company for the facilities granted in preparing this paper, and the many colleagues who have assisted.

In an endeavour to make this paper unbiased the author took the opportunity of communicating with other manufacturers, and thanks are due to the Hewittic Electric Co., and the Nevelin Electric Co., for their co-operation in providing information with regard to their specialised products for arc conversion equipment.

DISCUSSION

Mr. A. Newing: A point omitted is the economics of the situation of the rectifier, whether in or out of the box. The average cost of installing a rectifier or a motor generator set outside the box would be about £150.

Mr. J. Sturgeon: If the equipment is in the box, you are taking your lightest current over the longest run; this calls for a lighter cable and reduces the costs of switchgear in the box.

The Author: The A.C. input on the single-phase types is very much more than that on the 3-phase types. Therefore, the costs of cabling and installation of the 3- or single-phase types are very similar, and I doubt very much whether there is any appreciable difference in the cost of installation of either type.

Dr. F. S. Hawkins: Could Mr. Milne tell us a little more about the smoothing used? We have recently been interested in the supply of arcs to film studios.

The Author: In film studios the ripple content required is in no way comparable to that for a kinema arc; the trouble in the studio is microphonic pick-up. On a kinema rectifier, the ripple is smoothed out in the neighbourhood of 10% it is normally quite satisfactory. On the sets that are being made to supply arcs for studios, the ripple has to be as low as .05%.

Mr. S. A. Stevens: Mr. Milne has invited me to add to what he has said in regard to the metal rectifier.

At the outbreak of war, my Company had been working for some years on the selenium-iron rectifier, and had developed this to a stage where we had overcome ageing and de-formation, and instead of working at 12 volts per element, it can now work at 42 volts peak on each element; so, for the usual arc conditions, a hexaphase-bridge can be made up with only two elements in each arm of the bridge and each element only drops about 1 volt. The total voltage drop is of the order of about 5 volts, so that the efficiency of a 40 volt rectifier is of the order of about 90%, and allowing for the losses in transformer and ballast, it is possible to have an overall efficiency of more than 75%.

Choke ballast and individual rectifiers were first used with metal rectifiers and not with mercury bulb rectifiers. I quite agree with the disadvantages of using straightforward choke ballasting with any type of rectifier, in that you get a low

power factor. At a very early date, choke ballast of metal rectifiers was dropped, and a more developed form of ballast, a resonant filter, was adopted, and gave a power factor of about 0.9.

I also agree that three-phase is greatly to be preferred to single-phase. With three-phase hexaphase the ripple, without any smoothing, is about 6%, and you do not have to use any smoothing.

With regard to tapping switches versus contactors, the ideal is to get away from both. The current should not be adjusted while the show is running. Some engineers want to pre-set the value of the running current and to know that the staff cannot change it. Against that, some people do want to put rectifiers into the box, and want to regulate the current while the show is running. We rectifier manufacturers have got to meet that demand, and my own Company have in course of development a rectifier for mounting in the box, for regulating the current during the show, and without tapping switches or contactors. We do it by a continuously variable adjustment. We consider it should be three-phase as far as the rectifier is concerned, even if there is only a single-phase supply in the projection box.

A MEMBER: Is it possible for igniter control to be used to improve the control of mercury-vapour rectifiers and increase efficiency?

THE AUTHOR: Yes. Going away from igniter control, which in any case would be uneconomic for conversion equipment, many have toyed with the idea of using grid control, which is exactly the same in principle as igniter control. The trouble is, the more voltage control you have the worse the ripple gets. Therefore, from that point of view there is no economy, because the ripple is so high and the smoothing is so large. The capital cost would be high, power factor bad, and the efficiency low.

BOOK REVIEWS

BRITISH JOURNAL PHOTOGRAPHIC ALMANAC, 1947. 444 *pp.*+32 *gravure. Henry Greenwood & Co., Ltd. Price* 4*s.* (*cloth* 5*s.*).

A little belated, but none the less welcome, the *B.J. Almanac* contains its usual storehouse of information concerning photography and sub-standard kinematography.

A particularly valuable paper on emulsion sensitivity provides the cameraman with a useful guide to the practical aspects of sensitometry. Two papers on pictorial photography contain points equally applicable to kine-photography, as does an article on medical photography (although the author specifically excludes kinematography).

Although the section devoted to sub-standard work is all too brief, it nevertheless contains much useful data. The many pages of tables are as usual invaluable to any technician. R. H. CRICKS.

INFORMATION FILM YEAR BOOK—1947. *The Albyn Press*, 175 *pages*, 10*s.* 6*d.*

The publishers of this book have followed the well-tried plan of division of the contents into two broad sections: a reference section preceded by a series of signed contributions. It would be invidious to single out any of these contributions for individual mention; it is perhaps sufficient to say that there are twelve in all and that they are all authoritative, by well-known experts, and cover a wide variety of aspects.

To many the book will be primarily useful for reference purposes and it might have been better to have devoted a little more space to these sections where so often only the bare details are set out.

Under present conditions, the directory sections cannot expect to be complete and in some cases information was not supplied by the firms or organisations concerned. However, the book remains a valuable reference guide. DENIS WARD

UNITED NATIONS SCIENTIFIC ORGANISATION

Representatives of organisations from all over the world interested in the production of scientific films are to meet this autumn in Paris or Cannes to discuss the setting up of a World Federation of Scientific Film Associations.

This decision has been taken after consultation in Paris between members of the Scientific Film Association, the Institut de Cinématographie Scientifique and UNESCO.

THE LIBRARY

The response to the appeal for books for the Reference Library has resulted in a generous donation of 79 books from Major A. Cornwell-Clyne, M.B.E., M.B.K.S., F.R.P.S.

The books cover every aspect of colour and include two written by the donor: "Colour Cinematography," and "Colour Music—the Art of Light."

POLYTECHNIC KINEMATOGRAPHY COURSES

THE two-year course in kinematography, organised in conjunction with the Society at the Regent Street Polytechnic, has had a successful year.

Six students have left after completing the course, of whom two are ex-Service, the other four being liable to call-up. The examinations showed that academically these students were perhaps a little below the standard of some previous years. However, the lead taken by them in student activities, and their keenness in practical work, suggests that they will prove useful recruits to the Industry.

Ex-Service Classes

The twelve students who started the course last September have done a very useful year's work, and indicate that the ex-Service man makes an admirable student. The examinations show, however, that in some cases the interruption in their education is an academic handicap ; this is largely offset by their greater experience, which is of great assistance in practical work. One student has left, and the remaining eleven are engaged at present in shooting films to scenarios prepared by themselves.

The selection of twelve students to start this September proved difficult. From a large number of applicants, 27 came up before the Selection Board on June 18th. The twelve selected applicants are all ex-Service, and should continue the tradition of providing the Industry with suitable men, equipped with an adequate technical foundation. M. V. H.

Evening Classes

As in past years, three series of evening classes will be held at the Polytechnic during the coming scholastic year. The lecturer is Mr. Malcolm V. Hoare, B.Sc., M.B.K.S.

SENSITOMETRY AND LABORATORY PRACTICE

A course of 12 lectures designed to enable laboratory workers to understand the basic principles underlying processing, and studio workers to appreciate the requirements of the photographic process and secure the fullest co-operation from the laboratory.

Mondays at 6 p.m. commencing 22nd September, 1947.

1. The photographic process and its variables.
2. Plotting the H. and D. curve.
3. Information derived from the H. and D. curve.
4. Sensitometers. Production of test strips.
5. Gamma and contrast. Densitometers. Developing strips.
6. Emulsion speeds. Exposure and exposure meters.
7. Control of negative gamma and positive density. Stock testing.
8. Printers and their sensitometric control. Cinex strips.
9. Product gamma. Duping.
10. Control of sound, variable area. Duping and dubbing.
11. Control of sound, variable density. Duping and dubbing.
12. Developing machines. Solutions and replenishment and general laboratory practice.

Fee—£1

Enrolments may be made at the Polytechnic 15th, 16th, and 17th Sept. from 6.0 p.m.

SOUND-FILM RECORDING AND REPRODUCTION

A course of twelve lectures, designed for all who are concerned with the recording and reproduction of sound on film.

Commencing January, 1948.

PHOTOGRAPHIC OPTICS FOR THE FILM INDUSTRY

A course of lectures intended for those engaged in all branches of the film Industry who use lenses or other optical equipment.

Commencing April, 1948.

TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library

COLOUR STIMULUS AND COLOUR SENSATION.
P. J. Bouma and A. A. Kruithof, *Philips Technical Review*, Vol. 9, No. 1, p. 2.

The differences between the two conceptions, "colour sensation" and "colour stimulus" are discussed. Colour stimulus is the subject of trichromatic measurements, the results of which can be expressed in terms of dominant wave-length, chromatic purity, and luminosity. Colour sensation is purely subjective, and is influenced by many secondary factors. R. H. C.

THE SOUNDMAN
G. R. Groves, *J. Soc. Mot. Pic. Eng.*, Mar., 1947, p. 220.

The paper deals with the work of the sound recording engineer from the creative rather than the technical aspect, showing how progress in technique has accompanied improvements in the functional qualities of the various tools employed on the floor. N. L.

POSTWAR TEST EQUIPMENT FOR THEATRE SERVICING.
E. Stanko and P. V. Smith, *J. Soc. Mot. Pic. Eng.*, Dec., 1946, p. 457.

Wartime advances in ruggedness and portability are incorporated in the sound reproducer test kit described. It includes new multi-purpose instruments such as the battery-driven VoltOhmyst and the Triatic tester. The latter incorporates a capacity bridge and also a compact high gain amplifier which should be a valuable tool in signal tracing as it applies a negligible load to circuits under test. N. L.

CORRECTIVE NETWORKS.
F. L. Hopper, *J. Soc. Mot. Pic. Eng.*, Mar., 1947, p. 253.

The use of corrective networks in re-recording is briefly dealt with and the performance requirements set out. A suitable design is described giving wide control of gain or loss at various spot frequencies which may be selected, and data for calculating the circuit constants is given. N. L.

NEW METHODS OF RADIO PRODUCTION.
J. A. Sargrove, *J. Brit. I. R. E.*, Jan.-Feb., 1947.

The paper describes a new method of spraying metal on to moulded plastic plates to form complete electronic circuits, the metal deposit forming all circuit elements such as condenser plates, coil turns and wiring in metallic continuity. Apart from the value of this technique in mass production of simple circuits such as utility radio sets, it would seem to have many possible applications where large numbers of circuits to very accurate tolerances are required. N. L.

NEW METHOD OF PRODUCING ASPHERICAL OPTICAL SURFACES.
H. Rinia and P. M. van Alphen, *Tech. Cinématographique*, May 1, 1947, p. 951.

In a heated aspherical mould a 10% or 20% solution of gelatine is placed, and upon it a flat or spherical glass surface. The mould is cooled, and the gelatine in solidifying adheres strongly to the glass, while contracting to about 10% of its thickness. Different curvatures may be obtained from the same mould by varying the composition of the gelatine solution. The most important application of the method is in producing correcting lenses for Schmidt optical systems. R. H. C.

KINEMATOGRAPHY IN RELIEF.
Technique Ciné, May 29, 1947, p. 1022.

In the Relief-Lyon-France system of stereoscopic projection, right- and left-hand views are vertically compressed in the camera into the space of a single normal frame, and are projected, the right view in the upper half of the screen and the left view below. Each patron is provided with an individual viewing device, which corrects the proportions of the frames and superimposes them. Adjustments are necessary to allow for viewing distortion. R. H. C.

THE COUNCIL

Meeting of 2nd July, 1947

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), Rex B. Hartley, B. Honri, Leslie Knopp, A. W. Watkins, A. G. D. West (*Past-President*), H. S. Hind (*representing the Sub-Standard Division*), and R. H. Cricks (*Secretary*).

Rates of Subscription.—It was decided to increase by 10s. 6d. the Fellowship, Membership and Associateship subscription rates, but that Students' subscription and their special subscription rates to the *Journal* should remain as heretofore.

Papers Committee.—Progress on the 1947/8 lecture programme was reported, with certain alterations in the original proposals.

Journal.—It was reported that there were hopes that the cost of production might be reduced and it was decided to continue with the present arrangements for printing the *Journal* until the end of the year.

Education Committee.—As a result of the meeting of the Polytechnic Advisory Committee meeting of the 25th June, when twelve ex-service candidates were chosen from 27 applicants for the two-year course, it was agreed that there was no occasion for the award of a scholarship.

Training and Apprenticeship Council.—It was suggested that some months might elapse before the commencement of the scheme.

Branch Constitution.—As the Provincial Sections were unable to arrange Committee meetings during June, the Secretary announced his intention to attend meetings in Newcastle-on-Tyne and Manchester towards the end of July.

Sound Film Projectors.—Mr. Oram was appointed as the Society's representative on the B.S.I. Committee.

Proposed Equipment Division.—It was decided to submit to the next Council meeting suggestions for the proposed formation of an Equipment Division.

Theatre Division.—The Council expressed pleasure that the training scheme for projectionists had been approved by the C.E.A. Council.

Home Office Regulations.—Recommendations of the Theatre Division Committee on the study of draft Home Office Regulations were considered. A Committee was appointed, the members of which should it was agreed, represent the Society on the C.E.A. Technical Committee.

Joint Meetings with the A.C.T.—It was reported that five joint meetings had been provisionally arranged.

EXECUTIVE COMMITTEE

Meeting of 2nd July, 1947

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), R. H. Cricks (*Secretary*), Miss S. M. Barlow (*Assistant Secretary*).

Elections.—The following were elected :—

Frank Hill (Member), Wool Textile Employers' Council.
Joseph William Davies (Associate), Astoria Cinema, Forest Hill, S.E.23.
John William Stuart Moore Sudds (Associate), Golden Memories, Ltd., Margate, Kent.
Dorian Stanley Lloyd (Member), Chas. H. Champion & Co., Ltd.
Owen Hope Greet (Associate), Pathé Pictures Educational Dept.
Thomas Hugill Waterworth (Associate), M.G.M. Film Studios.
Stanley Albert Herbert (Associate), Kine-Technic Services, Ltd.

Transfers.—The following Associates were transferred to Membership :—

Harold George Hoar, RCA. Photophone, Ltd.
Charles Albert Evemy, Warner Bros. and First National Pictures.
Terence Pearson Hunter, Warner Bros. and First National Pictures.
Margaret Cardin, Margaret Cardin Cutting Rooms.

The following was transferred from Student to Associateship :—

Walter Lassally, Alliance Film Studios, Ltd.

THEATRE DIVISION

The retiring chairman of the Theatre Division, Mr. C. H. Champion, was unfortunately absent through illness from the annual general meeting of the Division, held on May 18th, 1947, Mr. S. B. Swingler, formerly deputy chairman, and newly elected chairman, officiated

Chairman's Report

Mr. Swingler, reporting on the year's work of the Division, said :

The Theatre Division Committee have during the past 12 months been actively engaged in dealing with many items, details of which you have already noticed in the reports appearing in the *Journal.*

The Theatre Division membership now totals over 340—this being a large increase since the last Annual General Meeting. I must now draw your attention to the fact that the Theatre Division does not now have the largest membership ; the Film Production Division now have the record.

Film Mutilation.—It was at your Committee's instigation that the Film Mutilation Committee of the B.K.S. was set up and we believe that this is the first time that any really serious effort has been made to deal with this difficult problem. Representatives from all Branches of the Industry are represented on the Committee dealing with this.

Papers Sub-Committee.—The Papers Sub-Committee arranged quite successful Theatre Division Meetings in the 1946–1947 season and I take this opportunity of expressing on your behalf appreciation to the Committee and the authors of the Papers, which have been so well received, and I am sure that the programme for 1947–1948 will be as successful in every way.

Library.—I would draw your attention to the Library which now functions. A considerable number of books are available for the use of members.

Branches.—The branches at Newcastle-on-Tyne and Manchester are continuing with their lecture programmes in a satisfactory manner. The Committee are meeting the Secretaries of both Branches on Thursday next, May 21st, with a view to ensuring closer liaison with London activities, after which it is certain that they will make substantial progress.

Journal.—The *Journal,* which is having its title changed to " BRITISH KINEMATOGRAPHY," will be a monthly issue commencing from July. This will keep all members fully informed of the activities of the Divisions.

I am sure I am voicing your approval in passing thanks to all Committees who have assisted during the year and will welcome all the new Committee members.

I should like to pay tribute to the retiring Chairman, Mr. Charles Champion, who has devoted a large amount of time to the Division and on your behalf I would ask the Secretary to convey to him your appreciation, with good wishes for a speedy recovery from his illne ss.

I cannot conclude without thanking the G.B. Picture Corporation for the continued loan of the Theatre—also Mr. Abbott, together with his staff and by no means least, those ladies who so adequately look after us with refreshments.

Election of Committee Members

Announcing the names of the newly appointed or non-retiring members of the Committee, Mr. Swingler reported that Messrs. P. W. Alston and R. Scott had been appointed scrutineers in the election ; they declared that Messrs. S. A. Stevens, F. H. Sheridaw-Shaw, and J. A. Walters had been elected.

On the proposal of Mr. H. J. O'Dell, a vote of thanks was accorded to the retiring chairman and committee.

SUB-STANDARD FILM DIVISION

Mr. W. Buckstone, F.B.K.S., retiring chairman of the Sub-standard Film Division, made the following report at the annual general meeting of the Division, held at the Wellcome Foundation on May 28th, 1947 :

During the past year your Division has made considerable progress. A most satisfactory yardstick with which to measure our progress is the membership figure for the Division. At the last Annual General Meeting the membership stood at seventy-four ; to-day the Division has 170 members, an increase during the year of nearly 100.

Meetings.—Five meetings have been held and all have been well attended. Members and guests have contributed to the discussions and the independent thoughts, which found expression, indicate the acute interest of members in all aspects of sub-standard.

The meetings have been held at the Wellcome Foundation and I wish to express our deep gratitude to the Director, by whom we are permitted to make use of one of the finest and best equipped lecture theatres in London. I would also like to thank Miss Anthony whose unfailing kindness is highly appreciated by all who refer to her on our Society's business.

The provision of refreshments at meetings has been considered, but the present difficulties in obtaining supplies has caused us to defer this matter for the time being.

Five-Year Plan.—Your committee prepared a plan to cover the expansion of the

Division over the next few years, and this was embodied in the Five-year Plan announced by the President of the Society

Physical Society Exhibition.—Arising out of a suggestion made at a meeting of the Division Committee, the Council arranged to provide a display of research films and "taking equipment" for the Physical Society Exhibition, which took place at the Department of Physics, Imperial College, Kensington, from April 9th to the 12th. The B.K.S. exhibit was well attended, and subsequently the Council decided to continue this association with the Physical Society and provide a display for the next exhibition.

Committees.—Members of the Division have served on various Committees and expressed the viewpoint of Sub-standard film users.

Election of Committee.—Following his report, Mr. Buckstone stated that Messrs. H. E. Dance and G. H. Sewell had been re-elected to the Committee. Mr. H. S. Hind had been appointed chairman.

Votes of thanks were moved from the chair to the Wellcome Foundation; to Miss F Anthony and her staff, for their assistance at meetings; and to the lecturers.

FILM PRODUCTION DIVISION

At the annual general meeting of the Film Production Division, the chairman, Mr. A. W. Watkins, A.M.I.E.E., F.B.K.S., F.R.P.S., reported that the membership of the Division had increased to no less than 347. Four meetings of the Division had been held during the session. Keen interest had been taken in the joint meetings with the Association of Cine-Technicians, the arrangement of which would in future be entrusted to the Division.

Recommendations had been made for the standardisation of sound and camera report sheets, and other technical matters were under consideration.

On the chairman's proposal, Messrs. D. Forrester and S. Course were appointed scrutineers in the election of committee members, which the chairman explained had not yet taken place.

On the proposal of Mr. D. Forrester, a vote of thanks was carried by acclamation to the chairman and members of the Committee.

Election of Committee

On May 16th, 1947, the scrutineers reported that the following had been elected to the committee: Messrs. F. Young, F. J. Cox, H. Waxman, and G. Burgess.

Council Representative

In view of the fact that Mr. Baynham Honri, the representative on the Council of the Division, was also elected as an Ordinary Member of Council, the election of another representative was authorised by the Council.

In response to a request for nominations, one member only, Mr. George E. Burgess received the necessary five nominations, and he was therefore declared duly elected.

THE ROYAL BETROTHAL

The Society joined in the universal pleasure concerning the Royal Betrothal and the following telegram was despatched to Princess Elizabeth on the 11th July :—

The President and Council of the British Kinematograph Society send their respectful congratulations upon the occasion of your betrothal.

The following reply was received from Buckingham Palace :

"*The President, The British Kinematograph Society.*

"*Please convey the Princess Elizabeth's sincere thanks to all who joined in your kind message on the announcement of Her Royal Highness's engagement.*

"*Lady-in-Waiting.*"

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of the Journal.

James Benson received a letter of appreciation from the President for his unfailing assistance to the Society, on the occasion of his relinquishing his general work for the *Kine Weekly* to devote himself exclusively to technical journalism for its associated publications.

[*Continued overleaf*

P. D. Collins, formerly of G.E.C., has on his release from the R.A.F. joined Cinema Television Ltd.

George Gunn is at present at the Technicolor Laboratories in Hollywood; he has recently been awarded the Fellowship of the R.P.S.

Cecil Hepworth was unable to be present on the occasion of the jubilee celebration of Nettlefold Studios, which he opened in 1897.

George H. Sewell has returned from East Africa, where he has been directing films for the Colonial Film Unit; he expects to be returning to Africa shortly.

E. P. Williams has recently returned from Australia, where he has been supervising production for Ealing Studios.

APPRECIATION FROM NEW ZEALAND

A tribute of more than special interest comes from New Zealand which expresses the desire of the Dominions for the furtherance of the exports of British Equipment.

Mr. G. F. J. Alward, the equipment manager of Messrs. Gaumont-Kalee, of Wanganui, suggests that improved service in British equipment would secure mastery over competition from other countries at present supplying Australia and New Zealand with both projection and sound equipment.

Designs from British manufacturers have considerably improved, observes Mr. Alward, and if reliability is obtained as well as service, the next few years will see a great change in the kinematograph industry.

RATES OF SUBSCRIPTION

The Council hereby gives notice that the rates of subscription of Associates, Members and Fellows will, as from January 1st, 1948, be increased in each case by 10s. 6d. per annum. The subscription rate for Students remains unchanged.

BRITISH KINEMATOGRAPHY

The Journal of the British Kinematograph Society

VOLUME ELEVEN, No. 3. SEPTEMBER, 1947

PROVISIONAL LECTURE PROGRAMME, 1947-48

Society Meetings

Oct. 8 **"The Law of Copyright and the Film,"** by ARTHUR KRESTIN, LL.B.
Nov. 12 **"Controlling the Elon-Hydroquinone Developer,"** by G. I. P. LEVENSON, Ph.D., B.Sc.
Dec. 3 **ANNUAL DINNER**
Dec. 17 **Presidential Address,** by I. D. WRATTEN, F.B.K.S., F.R.P.S.
Jan. 14 Newman Memorial Lecture : *Joint Meeting with Royal Photographic Society* : **"The Origin and Development of the Matte Shot Process,"** by W. PERCY DAY.
Feb. 11 **"Some Thoughts on Metals in Kinema and Related Equipment,"** by A. B. EVEREST, Ph.D., F.I.M., and F. HUDSON, F.I.M.
Mar. 10 **"Phase Modulation Principles applied to Sound Recording,"** by J. A. SARGROVE, M.Brit.I.R.E., A.M.I.E.E., D. A. BALL, A.M.Brit.I.R.E., and NORMAN LEEVERS, B.Sc., A.C.G.I., M.B.K.S.
Apr. 14 **"Colour Vision and the Film Industry,"** by W. D. WRIGHT, A.R.C.S., D.Sc.

Society meetings are held at the Gaumont-British Theatre, Film House, Wardour Street, W.1, commencing at 7.15 p.m. Light refreshments are served from 6.45 p.m.

Theatre Division Meetings

Sept. 28 **"Problems of Distribution and Maintenance of Release Prints,"** by A. E. ELLIS, M.B.K.S.
Nov. 23 **"Fundamentals of Colour,"** by W. D. WRIGHT, A.R.C.S., D.Sc.
Jan. 25 **"From Silent to Sound,"** by B. G. ANSTRUTHER, M.B.K.S.
Mar. 21 **"Safety Requirements in the Kinema,"** by A. F. STEEL, A.M.I.E.E.
Apr. 18 **Discussion Meeting.**

Theatre Division meetings are held on Sunday mornings at the Gaumont-British Theatre, Film House, Wardour Street, W.1, commencing at 11 a.m. Light refreshments are served from 10.45 a.m.

Sub-Standard Film Division Meetings

Oct. 1 **Discussion Meeting.**
Nov. 26 **"The Film in Colonial Development,"** by GEORGE PEARSON, Hon.F.R.P.S.
Dec. 10 **"Reversal Processing,"** by HEER ir. VERKINDEREN.
Feb. 4 **"Light Efficiency of Projectors,"** by W. BUCKSTONE, F.B.K.S.
Apr. 7 **Demonstrations of New Equipment.**
Apr. 23 *Joint Meeting with R.P.S. Kinematograph Section (to be held at 16 Princes Gate, S.W.7)* : **"Exposure Technique for Reversal Materials,"** by J. DUNN.

Sub-Standard Film Division meetings (with the exception of the lastmentioned) are held in the theatre of the Wellcome Foundation, Euston Road, N.W.1, commencing at 7.15 p.m.

Film Production Division Meetings

Nov. 5 **"Television Production in contrast to Film Production,"** by PHILIP H. DORTE, O.B.E., A.M.I.E.E.
Jan. 7 **"Power Supply for Studios,"** by F. S. HAWKINS, Ph.D., A.R.I.C., M.B.K.S.
Mar. 3 **"Processing of Colour Films,"** by W. M. HARCOURT, F.B.K.S., F.R.P.S.
May 8 **Visit to Studio and Demonstrations of Equipment.**

Film Production Division meetings (with the exception of the lastmentioned) are held at the Gaumont-British Theatre, Film House, Wardour Street, W.1, commencing at 7.15 p.m. Light refreshments are served from 6.45 p.m.

Manchester Section Meetings

Oct. 7 " **The Manufacture of Motion Picture Film,**" by A. E. AMOR, F.R.P.S.
Nov. 4 " **Arc Lamp Conversion Equipment,**" by J. C. MILNE, A.M.I.E.E., M.Amer.I.E.E.
Dec. 2 " **Electronics in Industry,**" by J. BAGGS. A.I.E.E., M.S.I.T.
Jan. 6 " **Light and Colour in Stage Presentation,**" by P. CORRY.
Feb. 3 " **Optical Equipment for Projection,**" by A. HOWARD ANSTIS, M.B.K.S.
Mar. 2 " **Light Production from the Carbon Arc,**" by H. P. WOODS, B.Sc., A.Inst.P., M.B.K.S.
Apr. 6 " **Projection Equipment,**" by R. ROBERTSON, B.Sc., M.I.M.E.
May 4 " **Planning the Projection Room,**" by C. H. BELL, O.B.E., M.B.K.S.

Meetings of the Manchester Section are held in the theatre of the Manchester Geographical Society, 16 St. Mary's Parsonage, Manchester, commencing at 10.30 a.m.

Hon. Secretary, Manchester Section : **ALBERT WIGLEY,** 15, Broadway, Walkden, Lancs.

Newcastle-on-Tyne Section Meetings

Oct. 7 " **Some Special Purpose Arcs,**" by C. G. HEYS HALLETT, M.A., M.B.K.S., A.I.P.E.
Nov. 4 " **A Treatise on Kinema Arc Lamp Reflectors,**" by A. BROWN, M.B.K.S., A.R.P.S.
Dec. 2 " **Arc Lamp Conversion Equipment,**" by J. C. MILNE, A.M.I.E.E., M.Amer.I.E.E.
Jan. 6 " **The Cathode Ray Tube,**" by G. PARR, M.I.E.E., F.K.B.S.
Feb. 3 " **The Film in relation to Television,**" by MARCUS F. COOPER, M.B.K.S.
Mar. 2 " **Optical Equipment for Projection,**" by A. HOWARD ANSTIS, M.B.K.S.
April 6 " **Kinema Engineering Efficiency,**" by H. E. WHITNEY, A.M.I.E.E., A.M.I.H.V.E., M.B.K.S.
May 4 " **Projection Equipment,**" by R. ROBERTSON, B.Sc., M.I.M.E.
June 1 " **Planning the Projection Room,**" by C. H. BELL, O.B.E., M.B.K.S.
June 8 **Discussion Meeting.**

Meetings of the Newcastle-on-Tyne Section are held in the Neville Hall, Neville Street, Newcastle-on-Tyne, 1, commencing at 10.30 a.m.

Hon. Secretary, Newcastle-on-Tyne Section : **EDWARD TURNER,** 30, Ettrick Grove, Sunderland, Co. Durham.

Joint Meetings with the Association of Cinema and Allied Technicians

Oct. 22 " **Set Construction Methods,**" by JOHN GOW.
Jan. 28 " **The Production of a Documentary Film,**" by JOHN GRIERSON.
Feb. 25 " **Design and Use of the Miniature in Motion Pictures,**" by JOHN BRYAN.
Mar. 24 " **Editorial Importance in Film Production,**" *Author to be announced.*
April 28 *Title to be announced.*

Joint Meetings with the A.C.T. are held at the Gaumont-British Theatre, Film House, Wardour Street, W.1, commencing at 7.15 p.m. Light refreshments are served from 6.45 p.m.

NOTIFICATION OF MEETINGS

The programme cards formerly issued, giving the entire lecture programme for the session, will no longer be published. Members should therefore keep the above programme available for reference.

In view of the monthly publication of the Journal, the postcards which were formerly distributed will also be discontinued. Instead, a programme card will be enclosed monthly with *British Kinematography*.

ADMISSION TO MEETINGS

The admission of non-members to meetings will in future be by invitation card only, which must be signed by a Member or Associate. An invitation will be found attached to the monthly programme card, which may be completed and handed to any interested non-member. Additional cards may be obtained on application to the Secretary, from whom non-members also may obtain invitations.

FUNDAMENTALS OF LATENT IMAGE THEORY

W. F. Berg, D.Sc., F.Inst.P., F.R.P.S. *

Read to the British Kinematograph Society on January 15, 1947.

THREE years ago Professor N. F. Mott lectured to this Society on the subject of latent image theory[1]. He is the co-originator of the modern concepts of latent image theory based on crystal physics, and he was using the language of the modern theoretical physicist. The present paper is meant to continue along the same lines and to deal in particular with the more peculiarly photographic end of the story.

Since the publication of the original paper by Gurney and Mott[2], advances have been made in several directions. Some of these were concerned with the basic theory which was confirmed all round ; others established fresh ground, obtaining results which are quite independent of any theory, although all fitting in well within its general framework. On the whole we can say that the Gurney-Mott theory has been an outstanding success, and has formed the basis for most of the fundamental photographic work done since its publication. More than that, it has acted as a very strong stimulus to research, and it may fairly be said that it fulfils all the requirements of a good theory.

Nature of the Problem

The so-called photographic emulsion is not an emulsion in the true meaning of the word, but a dispersion of small crystals of silver halides—mostly silver bromide—suspended in gelatine. It has been postulated for a long time that the light-sensitive unit in a photographic emulsion is the individual grain : we will here be entirely concerned with the behaviour of the single grain. Latent image theory sets out to give a description as complete as possible of the processes leading to the formation of the latent image in the grain. It is impossible, of course, to investigate the actual grain, if only because it is so small. There are 10^9 to 10^{12} of these grains, *i.e.*, up to a billion (British), in each square centimetre of a piece of photographic material. Each grain on the average thus weighs one billionth of a gram. These grains, however, are large on the atomic scale. It is well known that all crystals are built up from continuously repeating elementary units—in this case, the silver and halogen ions. Of these the photographic grain contains 10^9 to 10^{10} ion pairs.

In photographic research we thus always deal with the behaviour of millions of grains acting together and try to reach conclusions concerning the behaviour of the single grains. It is this step which provides the greatest difficulty in the interpretation of photographic data ; very often we must be in doubt. A curve may represent a progressive change occurring in many grains simultaneously, and thus be characteristic of the behaviour of the single grain. On the other hand, the curve may be characteristic of the way in which the various grains in an emulsion react one after the other, and may thus be quite unsuitable to be interpreted in terms of the behaviour of the individual grain. It is fortunate, in this connection, that in the density we have a very useful measure of the number of grains, since for any one emulsion those two quantities are almost exactly proportional to one another[3].

Exposure to light causes these grains to blacken by the reaction :

$$AgBr+light=Ag+Br.$$

Compared with the exposures normally given in a photographic camera very large amounts of light indeed are necessary to cause

* Research Laboratory, Kodak Limited, Harrow

this visible blackening, known as printing out, and consisting in the decomposition of the grains into silver and bromine according to the equation. It has been assumed for a long time that the very much smaller exposures producing a latent image have the same result., *i.e.*, the production of a small amount of silver in or on the photographic grains. If these grains are treated with a developer, they will be quickly and completely reduced to silver, whereas unexposed grains are reduced but slowly.

Only a few to a few hundred silver atoms are necessary to form a latent image in a grain. The amount of silver formed in an emulsion during exposure is so small that it has escaped all methods of detection except that of development. To illustrate how small an amount of silver we have to deal with, the following figures will be useful.

The value of the film required to provide one gram of latent image silver, based on the price of positive stock, comes to £50,000,000. Alternatively, the kinema industry in this country, consuming some 100 million feet of film in a few months, utilizes an amount of latent image silver of the order of one grain.

All these figures demonstrate well the difficulties of research work on the latent image. The subject somehow seems to lack a firm foundation, and all approaches are of an indirect nature. Almost all conclusions have to be drawn from photographic evidence, *i.e.*, from experiments involving development. A large amount of painstaking work has to be done before any definite conclusions can be drawn, and even then it often happens that later work contradicts previous conclusions. The work presented here, however, is felt to have stood the tests of time, and we can feel fairly confident that its essential features will not have to be altered.

Gurney-Mott Mechanism

Let us remind ourselves briefly of the Gurney-Mott picture of latent image formation. This is based on two well-known experiences obtained on large crystals of the silver halides. These crystals conduct electricity by virtue of the fact that some of the Ag^+ ions making up the crystal structure are loose and thus able to wander under the influence of an electric field. They are said to exhibit "ionic conductivity." Ionic conductivity like all ionic processes depends strongly on temperature.

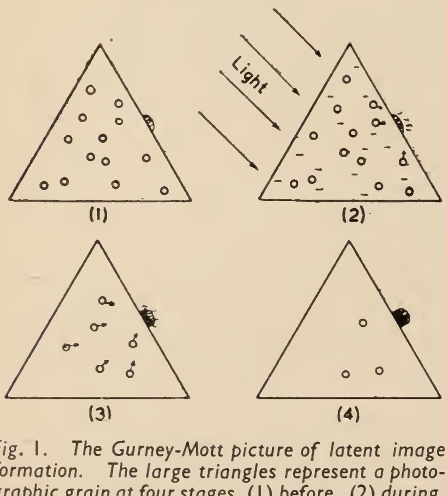

Fig. 1. The Gurney-Mott picture of latent image formation. The large triangles represent a photographic grain at four stages, (1) before, (2) during, (3) and (4) after exposure. **O** *are the mobile silver ions, — the electrons,* IIIIII *the sensitivity speck, and* ■ *the latent image silver.*

Under the influence of light an additional conductivity is found. This is due to electrons being released from the bromine ions and then able to move across the crystal under the influence of an electric field. This "photo-conductivity" does not depend on temperature, a fact which is characteristic of an electronic mechanism of conduction.

The two facts were coupled with a well-known photographic experience, *viz.*, that certain impurities are necessary to make photographic emulsions sensitive. These impurities have long been regarded as concentration or sensitivity specks on which the latent image collects, like water vapour

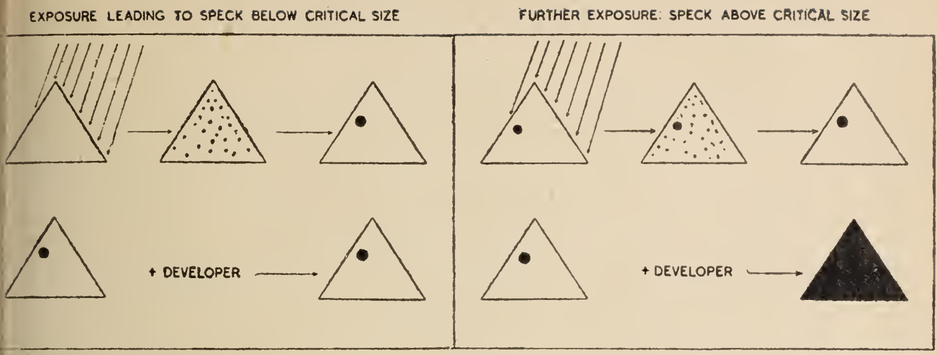

Fig. 2. A speck of silver of critical size is necessary to act as a latent image speck.

condensing on dust particles in the formation of fog. We now think that these specks act by trapping electrons released by light, thus becoming negatively charged. In this way, an electric field is set up and attracts the positive ions. It is seen that in this way, both components of silver atoms can move through a crystal, *i.e.*, the electron and the ion, and that silver collects on the sensitivity specks (Fig. 1). It is this which constitutes the latent image.

There is a good deal of evidence supporting the view that the latent image consists in a strictly localized change on the grain ; in other words, that the silver is concentrated in one or a few specks as is visualized by the Gurney-Mott mechanism. Thus, for example, development always begins at a few isolated points. Further evidence is produced by the electron micrograph pictures of photographic grains. The developed grain consists of a tangled mass of narrow threads of silver looking for all the world like a ball of steel wool[4]. The impression is created that the developed silver is squirted from the body of the grain like icing sugar from a gun at isolated points, which are interpreted as the latent image specks.

We may thus summarize the basic picture of latent image formation as follows :—

> The latent image on a grain is a small speck of metallic silver which is concentrated on the grain surface because of the existence of the concentration speck. The latent image speck must be of a certain minimum critical size before it can induce the rapid development characteristic for a grain carrying a latent image. (See Fig. 2.)

Reciprocity Law Failure

The Gurney-Mott mechanism accounted for some of the most puzzling features of the photographic process. Amongst these is the so-called reciprocity law failure. This is illustrated by Fig. 3 which shows sensitometric curves obtained for the same actual exposure ($E=I \cdot t$) brought about by varying the exposure time (t) and intensity (I) so as to keep the product ($I \cdot t$) constant. It is seen that there is an optimum intensity or time, and on both sides of this the speed of a photographic material falls off. Reciprocity law failure is plotted in various ways, one of which is used most frequently ; it is known as the "reciprocity curve." Fig. 3 also shows both how the so-called reciprocity curve is obtained from the characteristic curves of a photographic material and the way it is plotted. The log exposure ($I \cdot t$) necessary to obtain a constant density is plotted against the log intensity (I). Gurney and Mott[2] accounted for both low- and high-intensity failure

by considering that the electronic process is fast, and the ionic process relatively sluggish.

At low intensities of light the process of latent image formation is inefficient, since a very small speck of silver is unstable and liable to decompose. Thus the silver can recombine with the bromine atoms, formed as the result of exposure to light. Silver, therefore, has to be released at a sufficient rate to form a stable speck in a reasonably short time ; the lower the intensity of light the less the probability of a stable speck being formed in a grain, and the less therefore the photographic efficiency of light[5].

At high intensities the sensitivity speck is charged rapidly, and any further electrons are repelled until the more sluggish ions have moved up. In this way latent image formation is impeded and one might wonder what happens to the repelled electrons. It was this consideration that led up to one of the lines of research to be reported on here. There are two possible fates for the repelled electrons : they may be forced to recombine with the bromine atoms from which they came, or they may contrive to form latent image elsewhere in or on the grain. Luppo-Cramer[6] and others[7] have shown a long time ago that latent image is formed inside the grain as well as on its surface, and has furthermore suggested that the distribution of the latent image as between the interior and the surface of the grain, depends on the intensity of the exposing light ; in other words that it is connected with reciprocity law failure.

Latent-Image Distribution

In recent years there has been considerable interest in latent-image distribution. During the war, over 30 papers have been published on this subject in Belgium[8] ; other recent contributions originate from the Kodak Research Laboratories[7].

Basically, latent-image distribution is investigated by applying three types of solution. The surface image is developed in a " surface developer," which is one containing no solvent for the silver halide, and is thus considered

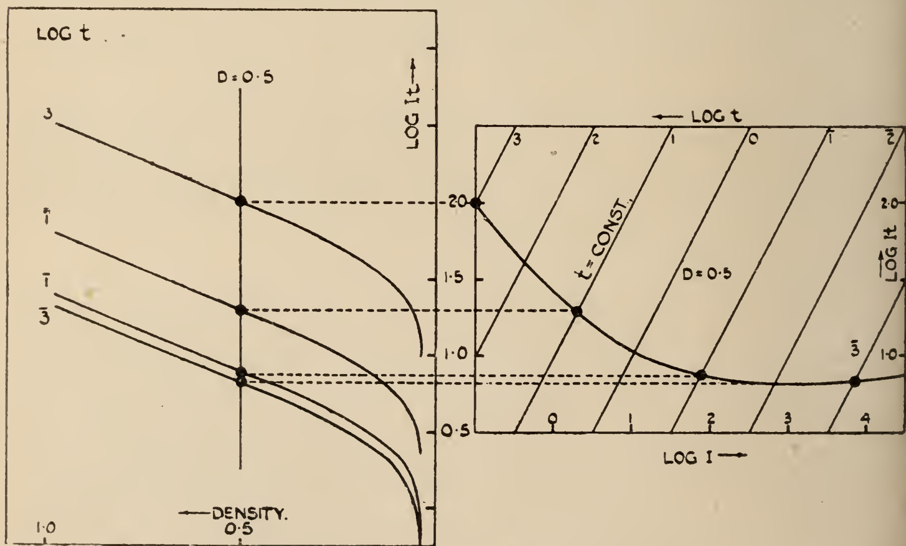

Fig. 3. The derivation of the reciprocity failure curve. Intensity scale characteristic curves for the same exposure I×t, but a range of times are plotted on the left. A line of constant density, here 0.5, is drawn through the curves. The log exposures necessary to produce this density are then plotted again the log I of the exposure.

to respond only to latent-image specks situated on the grain surface. The second solution is a bleacher which destroys the surface latent image without affecting the internal. Bleaching time and concentration are altered until the surface image is just destroyed. The third solution is an internal developer applied after the bleach bath. Various types of internal developer are available. The most convenient one is an ordinary MQ developer containing a sufficient concentration of a silver halide solvent such as hypo. The amount of silver halide solvent is adjusted so that the internal latent image specks are reached within a reasonable time ; too high a concentration would cause the emulsion grains to dissolve before they had a chance to develop. Other methods of internal development make use of the fact that silver iodide is less soluble than silver bromide ; on treating an emulsion with iodide ions the grains break up and the developer can reach the internal image.

Physical development after fixation is another method of internal development, but is not to be trusted implicitly, since a latent image for a chemical developer is not necessarily one for a physical developer, if only since heavier exposures are always necessary with physical development. Finally, the internal image may be developed by treating the emulsion with a silver halide solvent first, and an ordinary developer afterwards, reacting to the latent image laid bare. In this way, the distribution of the latent image throughout the grains can be investigated.

Using these methods, it is found that a sharp distinction can be obtained between surface and internal image. Furthermore, the distribution of the internal image has been studied ; this can usefully be sub-divided into a sub-surface and a deep internal image[8]. The sub-surface image is obtained with exposures of the same order of magnitude as those causing the surface image. The deep internal image is much slower than either, and therefore does not play an appreciable part for exposures in which we are normally interested.

Of all the results obtained on latent image distribution, we will select but two of the more important aspects—the Herschel effect and reciprocity failure.

Herschel Effect

The Herschel effect is defined as the destruction by red light of latent image produced in any known manner. Very heavy exposures as compared with those producing the latent image are required for its destruction, the basic mechanism of which is well accounted for by the Gurney-Mott theory. The red light is absorbed by the latent-image silver specks, which in consequence emit and thus lose an electron. The remaining speck is positively charged and as a result, loses a positive silver ion ; thus a complete silver atom is lost for each quantum of light absorbed.

There are two possible fates for the silver so lost from the latent image specks. If any halogen atoms remain from the original exposure, the silver and halogen can react to form silver halide—a process described as recombination. This is unlikely, however, since the Herschel effect can occur a long time after the original exposure when bromine atoms are presumably no longer available. It must be assumed, therefore, that the Herschel effect consists in a dispersion of the silver. If latent-image silver specks occur both on the surface and in the interior of the grains, absorption of light may shift the silver from the surface to the interior or other parts of the surface, or from the interior to other parts of the interior or to the surface. The last case was proved to exist by the following experiment :—

A blue-sensitive material was heavily exposed and the surface image

then bleached away. On further exposure a new surface image was formed, and in this formation a new spectral sensitivity peak occurred in the red due to the absorption of light by the internal latent image which is thereby shifted to the surface[9]. (See Fig. 4.)

Reciprocity Failure for the Internal Image

Fig. 5 shows a typical case of reciprocity failure for the surface and internal image, and also for that developed in an ordinary MQ developer, which always contains some silver halide solvent in the form of sodium sulphite. The surface image shows high-intensity reciprocity failure for exposure times and intensities at which the internal image shows low-intensity failure. In other words, the latent image is preferentially formed on the surface at low intensities of light and tends to form in the interior of the grains to an increasing extent the higher the intensity.

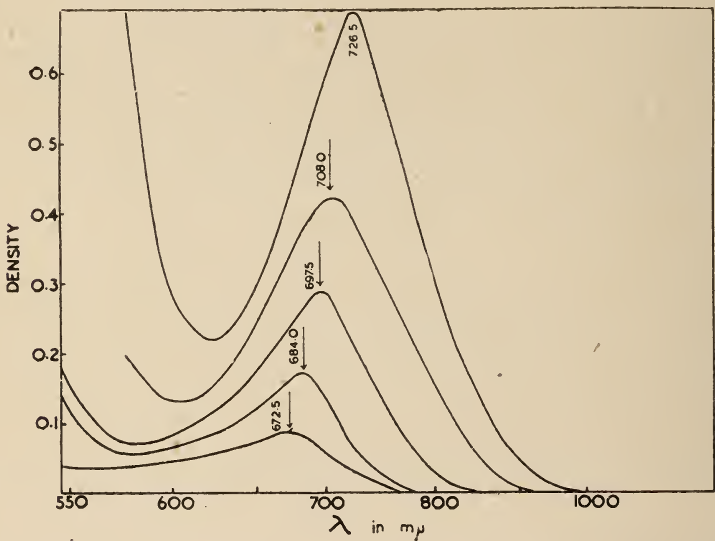

Fig. 4. Spectral sensitivity curves of an originally blue-sensitive material, which has been heavily pre-exposed and then bleached so as to destroy the surface latent image.

This finding, which was obtained on a large number of emulsions, and with various types of internal development, is of great practical and theoretical importance. According to its composition, a commercial developer will react more or less strongly to the internal image, although the surface image as a rule is more important. It is clear that misleading results have often been obtained when latent-image distribution was not considered. This applies in particular to statements on reciprocity failure of any given emulsion which should be made always in conjunction with the developer used. The knowledge of reciprocity failure of a given emulsion is of importance when considering this emulsion to be used under abnormal conditions, for example for high speed recording when the exposure times are very brief and the intensity is high[10]. In certain instances, it may pay to use an internal developer, although here of course one would not consider bleaching away the surface image first : the developer used would be a total developer, *i.e.*, one containing a silver halide solvent so as to react to both the surface and the internal images.

Latent Image Dispersity

Hopes of achieving in practice higher photographic speeds by using the internal developer for high intensity exposures were not, however, in general

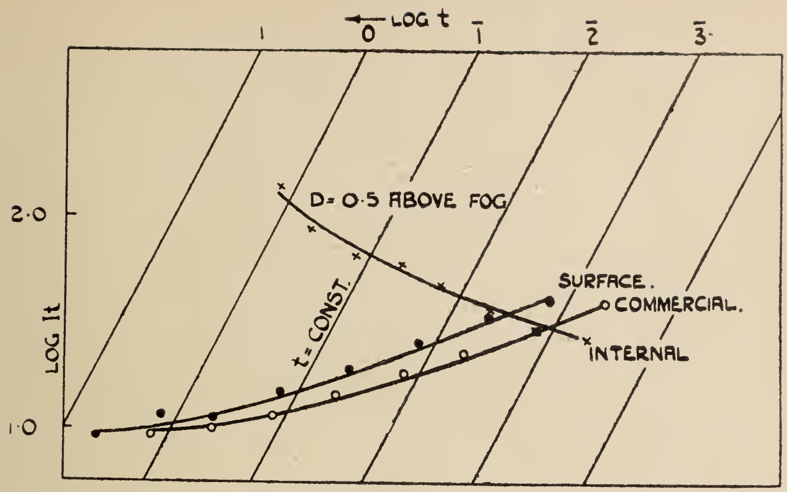

Fig. 5. Reciprocity failure curves for the surface and the internal latent image and for that developed by a commercial M.Q. developer.

fulfilled. We now believe that we understand why this should be so ; to explain the fact, we have to consider how a latent-image speck is built up[11]. This is most easily seen on considering a curve in which the density is plotted against the time of exposure (not the log exposure time as is common sensitometric practice). Almost all photographic materials produce a curve with a toe (Fig. 6). The significance of this result, is that during the early stages of exposure something accumulates which allows the density to grow at an increasing rate as exposure progresses. This something we have termed the " sub-image " which is short for " sub-developable latent image."

The presence of this sub-image can be demonstrated in other ways. If two exposures are added then as a rule the resulting density is larger than the sum of the densities produced by the individual exposures. The additional density is proof of the existence of sub-image produced by the first exposure and brought to completion by the second exposure. In any particular instance, the amount of sub-image must be defined and determined in conjunction with the development treatment : it is quite possible for sub-image for one treatment to behave as a full image for another.

The concept of the sub-image has been found very useful and its formation has been studied under various conditions. Thus the ratio of the sub-image to the full latent image has been investigated for various intensities of light. This has been made possible by applying the process of latent image intensification : the sub-image present in an emulsion can be built up to the full image by a post-exposure at a sufficiently low intensity. At this low intensity, the light forms but little new latent image, *i.e.*, little fog, because of the

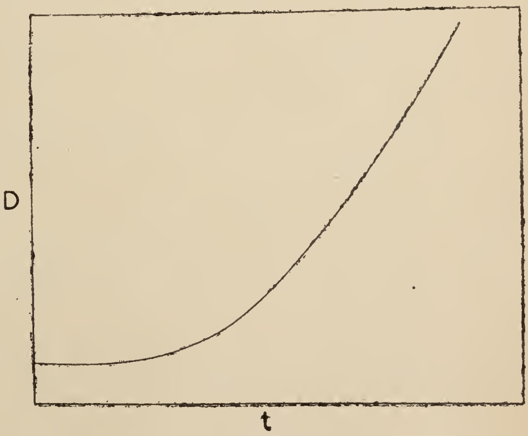

Fig. 6. Typical density-exposure time (note : not log t) curve.

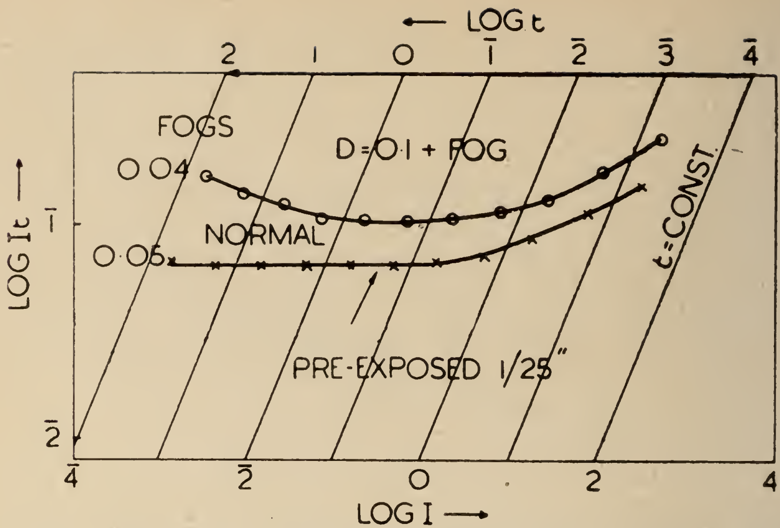

Fig. 7. Reciprocity failure curves for a material pre-exposed at 1/25th sec. and control (" normal"). The pre-exposure has caused the curve to flatten out at the low-intensity end.

low-intensity reciprocity failure. The light does, however, continue to build up the sub-image specks until they are sufficiently large to form a latent image. This is demonstrated in Fig. 7 in which reciprocity curves are drawn for a material which has received a brief pre-exposure at 1/25th of a second. This pre-exposure produces a supply of sub-image grains, and it is seen that the emulsion in consequence loses its low-intensity failure, *i.e.*, the latent image is now formed at full efficiency whatever the intensity of light. One concludes that low-intensity failure is confined to the stage of sub-image formation, and does not occur in the second stage of completion of the latent image.

We can, therefore, regard a low-intensity post-exposure as a method of " developing " the sub-image and may apply this method of development to exposures of widely different intensities. The result is shown in Fig. 8,

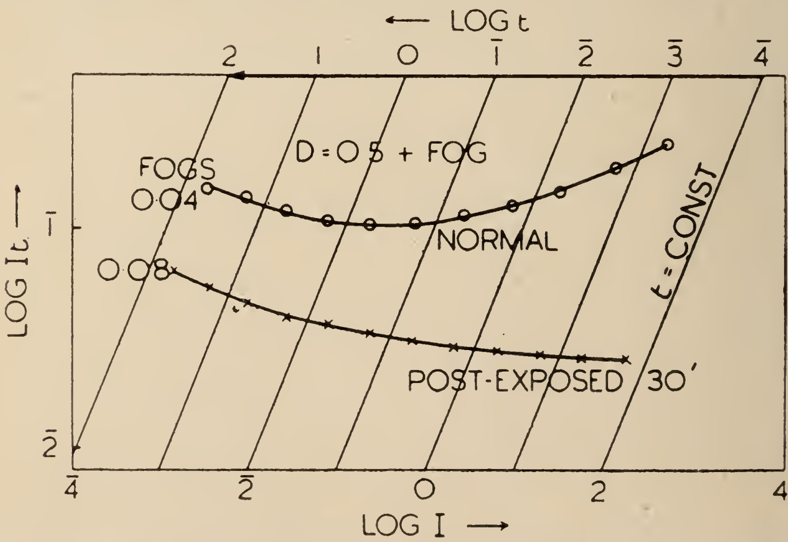

Fig. 8. Reciprocity failure curves of a material with and without (" normal ") uniform post-exposure of long duration. The post-exposure has " developed " the sub-image ; in consequence, high-intensity failure has disappeared.

4 3

Fig. 9. The best prints obtainable from sections 1, of an under-exposed aerial negative, 2, the same negative post-exposed for 30 minutes, 3, the same negative uranium-intensified after processing, and 4, the negative both post-exposed and uranium intensified. The result represents a total speed increase of about ten times.

again in the form of a reciprocity diagram, and indicates that a constant post-exposure reveals increasing amounts of sub-image as the intensity of the first exposure goes up.

This result is of great significance. Reciprocity failure at high intensities is eliminated and is thus shown to be confined to the second stage in the formation of the latent image. Sub-image formation seems to be more efficient the higher the intensity of light. The increasing preponderance of sub-image as the intensity increases indicates that, on the whole, latent image specks due to high intensities are smaller than those formed at low intensities of light. In consequence, the high-intensity image develops more slowly than one of the same final density obtained at low intensities of light.

In order to get full speed for an exposure of short duration to high-intensity light, full development is necessary ; latent image intensification is another way of achieving the same end, often more efficiently. Under extreme conditions one may have to utilise this somewhat inconvenient process. A striking example of what can be achieved is shown in Fig. 9, in which a speed increase of about 10 times is obtained by post-exposure and uranium intensification.

To sum up, we have found that the Gurney-Mott theory accounts for many photographic experiences. At high intensities of light the latent-image specks have difficulty in growing at the rate at which electrons, and therefore, silver atoms, are released in the grains by the absorption of light. In consequence, the latent image forms in a more highly dispersed form. The latent-image specks tend to be smaller, and some of them are found in the interior of the grains. The concept of the sub-image is introduced. Reciprocity failure at low intensities is due to inefficiency in the sub-image

stage ; the second stage is fully efficient. A pre-exposure at high intensity can therefore eliminate low-intensity failure. The ratio of sub-image to full image increases with the intensity of light. Low-intensity post-exposure is a method of developing this sub-image. High-intensity reciprocity failure can be eliminated by a post-exposure at low intensity and is therefore confined to the second stage of latent-image formation.

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DISCUSSION

Mr. G. S. Moore : There may be a possibility of using latensification technique in sound recording, where exposures of the order of 1/20,000th second are usual.

From the work that has been done on the internal and external latent image, have there emerged any possibilities of using better developers than our present developers for improving speed of kine. negatives or sound recording films ?

The Author : With variable area sound film, at any rate, the main requirement is to get sufficient contrast and resolution ; one would not have thought that speed was a major consideration. A post-exposure is liable to decrease the contrast rather than increase it.

Regarding the question of using internal development for increasing speed, tests have been made at various times, and have always been disappointing. It looks as though by far the best hope is to find a developer which works well with small latent image specks. In the developer known as RAF pyro-metol, we have one that does just that, and often gives considerably higher effective speeds.

Mr. B. C. Sewell : Would you get a particularly fine-grain image with pyro-metol developer ?

The Author : Pyro-metol tends to give rather a grainy image. It is a very energetic developer, which seems to have an almost explosive action on the grains, thus making them larger than would an ordinary developer.

Mr. L. Isaacs : What type of developer would be a surface developer ?

The Author : All commercial developers are a fairly close approximation to a surface developer, but to get a perfect one sulphite must not be used as a preservative because of its solvent action, but carbonate is satisfactory. Glycin carbonate, and also a catechol formula, are satisfactory surface developers.

Mr. L. Isaacs : What developer would you recommend for use with long exposures and low intensity ?

The Author : One would give a pre-exposure at a fairly high intensity of light. If really long camera-exposure times are in question, one would then get quite an appreciable increase in speed. The pre-flash exposure time should be of the order of 1/25th second, but not much shorter. This causes a sub-image to be formed. If the exposure time is much shorter, one also gets an internal image which counteracts the effect of the sub-image on the surface. Using an exposure time of 1/25th second, then, the intensity should be so adjusted as to obtain a fog level of not more than 0.2 or 0.3 on development in Kodak formula D76 or D16. Doing this, one can reckon to get a speed increase of two or three times if the camera-exposure time is of the order of two or three minutes. It does not matter what colour of light is used for the pre-flashing as long as it produces a sufficient density in the time stated.

Mr. G. S. Moore : A simple rule to remember this fogging technique for increasing speed is : if your camera-exposure is going to be of long duration, you give a short pre-exposure ; if your camera exposure is going to be short, of the order of 1/25th second or less, you give a long fogging

exposure after the camera exposure. The short exposure always comes first, whether it is the camera exposure or the fogging exposure.

Mr. W. Buckstone : There must be a considerable difference in time between the pre- or post-exposure and the main exposure?

The Author : Yes, the difference must be of the order of 1,000 or 10,000 to one.

Mr. W. Buckstone : Friese-Greene used a clear sector in the shutter, which gave a pre-exposure to the colour exposure ; this was in 1911.

The Author : A similar practice is carried out in certain laboratories, where a brief flash exposure is given before processing. The effect of this is more to influence the shape of the characteristic curve than to give an actual increase of speed, although the speed does in fact go up. In this way the threshold exposure is decreased.

A Visitor : Some years ago mercury intensification was advised.

The Author : It is somewhat unreliable, for reasons which are not fully understood. If a material is treated with mercury vapour, either before or after exposure, it is found that reciprocity failure can be eliminated both at high and low intensities. Mercury treatment, therefore, behaves very much like an exposure to light. The effects are said to evaporate after some time, therefore its significance is largely theoretical.

Mr. F. Bush : In some process shots, after an exposure on one part of the frame area, a delay is inevitable of two or three weeks before you can complete the exposure. As a result of hand tests, we find we can match densities fairly well. Then the film goes to the laboratory, and is developed, perhaps after two or three hours, and we find that the process has gone awry. You have got a built-up of the latent image on the more recent exposure, but it is difficult to assess its extent.

The Author : Most modern fast emulsions are liable to latent image growth. No-one appears to have studied this property in detail, to the extent of comparing different emulsions. Nothing but practical experience with a given material would help to deal with this problem.

Mr. F. Bush : In what time would the limit of the build-up be reached?

The Author : The process is probably an exponential one, which means that the biggest build-up occurs in the first few hours. It would perhaps be practicable to hold up processing for 24 hours, assuming that the build-up had practically stopped after that time.

PROVINCIAL SECTIONS

With a view to discussing the transference of the existing provincial sections of the Theatre Division to the status of branches, the Secretary attended meetings of the Newcastle-on-Tyne and Manchester Committees on July 23rd and 24th respectively.

By courtesy of the local branch of the Cinematograph Exhibitors' Association, meetings of the Newcastle-on-Tyne Committee are held in the Association's committee room in Grainger Street. The chair was taken by Mr. R. E. Greene, M.Brit.I.R.E. ; the secretary is Mr. E. Turner, and other members of the Committee present were : Messrs. A. Brown, A.R.P.S., W. Carr, R. E. Eadie, A. B. Stuart, and L. A. Wilson ; Mr. G. Dobson was unfortunately absent.

The meeting of the Manchester Committee was held in the offices of Messrs. G. B.-Kalee, Ltd. In the absence of the chairman of the Section, Mr. A. Tuckett, the chair was taken by Mr. J. F. Kinniburgh ; the secretary of the Section is Mr. A. Wigley, and the committee consists of Messrs. F. G. Donaldson, L. H. Mould, and S. Wilson.

A draft branch constitution, prepared by the Provincial Sections Sub-committee of the Theatre Division, under the chairmanship of Mr. R. R. E. Pulman (Fellow) was submitted to each Committee. Both Committees accepted the constitution in principle, subject to reservations concerning the financial aspects. The views expressed by the Committees have since been accepted by the Executive Committee.

In both cases, details were submitted of the lecture programme for the coming session, arranged by the respective secretaries in conjunction with Mr. Pulman (*see Page* 74).

In the case of the Manchester Section, the proposal that occasional meetings should be arranged in Liverpool was favourably considered. Arrangements were also discussed for the reporting at greater length of meetings in British Kinematography.

Visual Education Digest, published by British Instructional Films, Ltd., contains a summary of the Government's scheme to promote the use and development of the kinema in the classroom and introduces a wide range of educational subjects for exploration.

MOTION PICTURE LABORATORY PRACTICE AND OPTICAL PRINTING

W. M. Harcourt, F.B.K.S., F.R.P.S.* & T. Howard, M.B.K.S., F.R.P.S.†

Summary of papers read to a joint meeting of the British Kinematograph Society and the Association of Cine-Technicians, on October 16, 1946.

THE first joint meeting held with the Association of Cine-Technicians was opened by Mr. W. M. Harcourt, who read the paper previously delivered to the Society[1], in which he had dealt with fine-grain stocks, chemical analysis, developments in Agfacolor and Anscocolor, and in printing and developing plant, and had also described two new densitometers.

Mr. Howard then presented his paper, which embraced the matter of a paper which he had previously delivered to the Society[2] on the design and operation of optical printers, together with some comments on the sensitometric aspects of optical printing.

The use of lavender stock, he said, had been almost entirely superseded by fine-grain duping positive and duping negative. The master print must be carefully graded, with a maximum density of 1.75 and a minimum of .60. The master print must be developed to a gamma of 1.2 or 1.3, and the duping negative to a gamma of .6 or .7. The product gamma should thus be less than unity.

The speaker described the many special effects which could be produced on the optical printer; wipes, dissolves, split-screen shots, montage sequences, etc., The adding of clouds was quite a frequent requirement.

Another field of application of the optical printer was the superimposition of cartoon figures upon scenes containing human figures. Such work called for an accuracy of registration of the order of .001 in. for black-and-white work, or in Technicolor, with its three negatives, of .0001 in. Mr. Howard concluded his paper by a description of the travelling matte process, first used in "The Thief of Bagdad."

DISCUSSION

MR. C. J. PHILLIPS: In America I attended a demonstration of Elon and Hydroquinone determination by means of the *p*H meter. That is considerably quicker than chemical analysis, and I think it is a method that should become widely used in this country.

MR. W. M. HARCOURT: It is a development of the determination of Elon and Hydroquinone by using a *p*H meter in conjunction with potentiometric titration. I do not believe it is any quicker, but a finer end point is obtained. We hope to have such an instrument at Denham in a short space of time.

MR. N. POTTER: Could Mr. Harcourt tell me how many developing machines were used in America to accompany the high-speed printers, and the speed at which the developing machines run? Are there special characteristics in the joins in these huge reels of stock, bearing in mind the great strain?

MR. W. M. HARCOURT: They have a battery of nine developing machines running at a speed of 240 feet per minute. In order to strengthen the joins made on a Bell & Howell splicer, a piece of cellophane-backed adhesive tape is wrapped. This is squeezed tight in a press and where the machines have sprockets, the tape is sprocket-punched at the same time.

MR. W. LASSALLY: Can Mr. Howard tell us why before and after a dissolve there is often a distinct jump in quality?

MR. T. HOWARD: In American films, the optical dupe is run through for the length of the film. I think it is the exception today to find optical films that "kick."

* Denham Laboratories Ltd. † M.G.M. British Studios Ltd.

[1] *J. Brit. Kine. Soc.*, Vol. 8, No. 3, Oct./Dec. 1945, p. 73.

[2] *J. Brit. Kine. Soc.*, Vol. 5, No. 3, July, 1942, p. 77.

CURRENT PROCESSES OF COLOUR KINEMATOGRAPHY

Jack H. Coote, M.B.K.S., F.R.P.S.*

Summary of paper read to a joint meeting of the British Kinematograph Society and the Association of Cine-Technicians on November 20, 1946.

THE paper which he had formerly delivered to the Society[1] formed the basis of a lecture and demonstration given by Mr. J. Coote to the second joint meeting with the Association of Cine-Technicians. In this paper, the author had discussed the Dufaycolor, Technicolor, Agfacolor, Anscocolor and British Tricolour processes. On the present occasion he gave further details of the Anscocolor process.

A special soft gradation taking material was now available, intended for printing on to a high contrast release material. A new duping material had also been introduced ; all these films were processed by reversal. In order to maintain colour brilliance in the final print, a new masking method had been developed, employing a low gamma monochromatic mask, which was optically printed from the colour original.

Mr. Coote also gave further details of the Cinecolor and Magnacolor systems; the latter, he said, was soon to be replaced by another two-colour process, Trucolor. Cinecolor was known to be a part metallic-toning, part dye-toning, process, based upon the use of duplitised positive stock, and Magnacolor was probably very similar. Trucolor, the speaker suggested, probably comprised a material having two emulsion layers coated on one side of the base, the outer emulsion containing a substantive blue-green coupler, and the inner one an orange-red colour former.[2]

The speaker suggested that the situation in regard to two-colour printing should interest the laboratories in this country, since it would obviously be more satisfactory for this country to import duplicate negatives than prints.

The paper was illustrated by sequences from the following films :

"*What is Colour?*" (16 *mm. Technicolor*) *by courtesy of I.C.I.*

"*English Village*" (35 *mm. Technicolor shot in Monopak*) *by courtesy of Darrel Catling, M.B.K.S.*

"*Hands full of Power*" (16 *mm. Kodachrome*) *by courtesy of United Motion Pictures, Ltd.*

"*Sports Parade in Moscow*" (35 *mm. Agfacolor*).

"*Enchanted Forest*" (*Cinecolor*).

"*Unusual Occupations*" (*Magnacolor*).

DISCUSSION

MR. GREY : Has Mr. Coote any observations to make in regard to temperature control in processing?

THE AUTHOR : It is much more critical in colour than in black-and-white. In the case of Agfacolor, baths have to be worked at a fairly low temperature because of the risk of frilling, and the temperature must not exceed 65° F.

MR. C. J. PHILLIPS : I have actually seen three-colour Cinecolor in America, and it was extremely good. I was assured that the cost would be about four times that of black-and-white.

MR. SMALL : Could Mr. Coote tell us whether, when correcting filters are introduced during processing of colour films, the judgment is that of the operator, the cameraman, or a colour meter?

* British Tricolour Processes, Ltd.

[1] *Proc. B.K.S. Film Prod. Division.* 1945/6, *p.* 15.

[2] It is now known that the first Trucolor prints to reach this country, are in fact coated on both sides of the base.

The Author : In passing a print, the cameraman and director and the laboratory technicians will all be involved in deciding upon a satisfactory print. The difficulty after that will be to maintain a similar rendition in all subsequent prints ; for this the laboratory staffs must obviously be responsible.

A Visitor : Can you clear up the patent situation? Are there any restrictions?

The Author : I do not really know. I understand that a number of patents are held by a Swiss Company, and the situation is by no means as straightforward as was thought.

BOOK REVIEW

THEATRE TELEVISION. RADIO CORPORATION OF AMERICA.

This booklet is a publication of R C A covering the plans on which they were working in 1945. It starts by describing in a very general manner the various items of equipment which are required to provide a television programme to the theatre, such as studio cameras and outside broadcast units. This is followed by a description of the big-screen television projector employing the Schmidt 30-inch mirror system which was installed for a period in the New Yorker Theatre.

A large section of the book is then taken up with a very elementary introduction to electronics and simple circuits. This is then followed by a very simple introduction to the principles of the Iconoscope camera and the Kinescope projection tube.

All this central section is very elementary to the radio and television engineer, but is purposely written in a manner which makes an extraordinarily good introduction to those who are not versed in these new techniques. This is because the book is written primarily for theatre owners and technicians and it sets out to provide the theatre industry with some of the basic facts about theatre television. Those members of the Society who wish to know these facts are recommended to borrow this book and read it through, remembering that it was written with an optimistic pen.

The last chapter is particularly interesting as it predicts the mode of operation of the theatre television-projector and includes 11 photographs showing the forms of distortion which can be expected by mis-adjustment of the controls of the receiver.

The reader must bear in mind that the impression is created that all this equipment is available and is a complete going concern in America, particularly as two appendices have been added which supply an imposing list of television stations for which application has been made in America, only a few of which are, of course, working at the present time.

Finally, there is a section on first aid "to enable every projectionist to give adequate first aid and thereby prevent loss of life," which is rather a peculiar inclusion in a technical book. One would have thought that adequate precautions could have been taken in the design of this type of equipment to make this last chapter unnecessary. T. M. C. Lance.

16mm. TEST FILMS

The Society has received, by arrangement with the Society of Motion Picture Engineers and the British Standards Institution, specimens of the following American 16 mm. test films :

Z52.7–1946	Snake Track Test Film (Field Type).
Z52.7–1946	Snake Track Test Film (Laboratory Type).
Z22.44–1946	No. 2 Multifrequency Test Film.
Z22.43–1946	No. 3 3,000-cycle Test Film.
Z52.10–1944*	No. 4 Buzz Track Test Film.
Z22.42–1946	No. 5a 7,000-cycle Test Film.
Z22.42–1946	No. 5b 5,000-cycle Test Film.
Z22.45–1946	400-cycle Test Film. *Travel Ghost.
Z52.6	

A glass test plate Z22.53–1946, for testing the resolving power of lenses* has also been received. (Those items marked * are illustrated in the *Proceedings of the Substandard Division,* 1944 45, p. 19). Most of the relevant American standards may be seen in the Society's Library.

The above are available for inspection by intending purchasers. Orders may be placed through the British Standards Institution.

THE PRINCIPLES OF AMPLIFIERS AND AMPLIFICATION

George Dobson, M.B.K.S.*

Summary of paper read to the B.K.S. Newcastle-on-Tyne Section on October 1, 1946.

MR. DOBSON commenced his paper by outlining the requirements of an amplifier, chief of which was that the output power must be proportional to the input voltage in every way, and at all frequencies. Any deviation would produce two types of distortion, amplitude or harmonic distortion, and frequency distortion, the latter being due to the amplifier gain not being the same at all points of the frequency spectrum. Another type of distortion, phase distortion, was not of great importance in audio-frequency work.

The power output needed would depend on the size of hall and the type of speakers employed. It had been suggested by the S.M.P.E. of America, that one acoustic watt should be delivered to every 1000 square feet of floor space. Average values for loud-speaker efficiencies were 25% when horn loaded and 5% when used in conjunction with a flat baffle.

Amplifier performance depended largely on the functioning of the valves. Three parameters or characteristics of the valve were dependent largely upon the geometrical construction of the valve : 1—the amplification factor, or ratio between the anode voltage and grid voltage creating it ; if the amplification factor were μ and the grid voltage V_g, the anode voltage would be μV_g ; 2.—the mutual conductance, or the ratio between the valve current and the grid voltage which produced it ; and 3.—the dynamic plate resistance or internal impedance of the valve.

To obtain maximum power with limited distortion, the external load impedance of a valve must bear a definite ratio to the internal impedance ; for a triode the ratio was 2, for a pentode 5. Regarding the valve as a generator, Mr. Dobson gave some mathematical illustrations which demonstrated that the potential developed across a load depended upon the relation of the load to the internal impedance of the valve.

The speaker next explained the principle of resistance-capacity valve coupling. Referring to the equivalent circuit of Fig. 1, in which the valve developed an e.m.f. of μV_g across the internal impedance R_a and the parallel resistances R_L and R_g (the effect of the condenser C could be neglected at middle frequencies) the speaker explained that the current in the circuit would be—

$$I_a = \frac{\mu V_g}{R_a + R_e}$$

where— $$R_e = \frac{R_L R_g}{R_L + R_g}$$

and the voltage across $R_e = I_a \times R_e$

$$= \frac{\mu V_g \times R_e}{R_a + R_e}$$

The stage gain $$= \frac{\mu V_g \times R_e}{V_g(R_a + R_e)} = \frac{\mu R_e}{R_a + R_e}$$

* RCA Photophone Ltd.

The effect of the condenser C must be taken into account at the higher and lower frequencies.

The speaker next turned to transformer coupling, of which Fig. 2 was the equivalent circuit. The external load impedance was due to the resistance and inductance of the transformer primary winding (for simple calculations, its resistance could be neglected). The alternating current flowing in the anode circuit was—

$$I = \frac{\mu V_g}{Z}$$

where $Z = \sqrt{R_a^2 + (2\pi f L)^2}$ or $\sqrt{R_a^2 + X_L^2}$

$$I = \frac{\mu V_g}{\sqrt{R_a^2 + X^2}}$$

The voltage developed across the transformer primary was—

$$E = \frac{\mu V_g \times X_L}{\sqrt{R_a^2 + X^2}}$$

The voltage at the grid of the following valve would be equal to the product of this voltage and the turns ratio of the transformer.

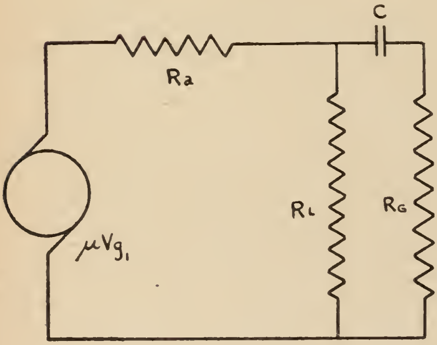

Fig. 1. Equivalent Circuit of Valve.

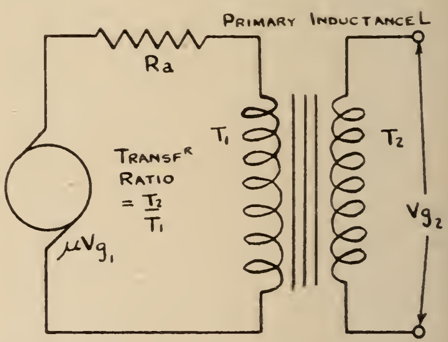

Fig. 2. Equivalent Circuit of Transformer Coupling.

The speaker next turned to consideration of push-pull circuits, and explained the phase inversion circuit. With such circuits, he said, it was possible to develop more than twice the output power of a single valve. The demand for still greater power led to the introduction of the American 6L6 and its British counterpart KT66 beam tetrode valves, and by operating these under Class A or Class AB conditions, it was possible to obtain large output currents at moderate cost.

Finally, the speaker dealt with the matching of the loud-speaker to the output stage of the amplifier. In Fig. 3 he showed a 6L6 valve delivering 10 watts into a 4,000 ohm load, the anode voltage being 300 volts, screen volts, 200, grid bias 12 volts.

The anode current was 50 m.a. and screen current 4 m.a. under these conditions. It was required to find the value of the resistance R_k in order to develop the required grid bias voltage, and also the turns ratio of the output transformer if the load speaker resistance were given as 15 ohms.

The bias voltage was equal to the value of the resistance R_k multiplied by the current flowing through it, which would be the sum of the anode and

screen currents, or $I_a + I_s$. Hence :

Total current = 54 m.a.

Bias voltage $= R_k \times .054$ amp.

$$R_k = \frac{12}{.054} = 220 \text{ ohms.}$$

If the 6L6 delivered 10 watts into a load of 4000 ohms, the voltage across the transformer primary would be—

$$E_p = \sqrt{10 \times 4000}$$
$$= 200 \text{ volts.}$$

As the 10 watts were also delivered to the loud-speaker of 15 ohms, the required voltage across the speaker would be—

$$E_s = \sqrt{10 \times 15}$$
$$= 12.1 \text{ volts.}$$

Therefore the turns ratio of the transformer was—

$$\frac{E_p}{E_s} = \frac{200}{12.1} = 16.5$$

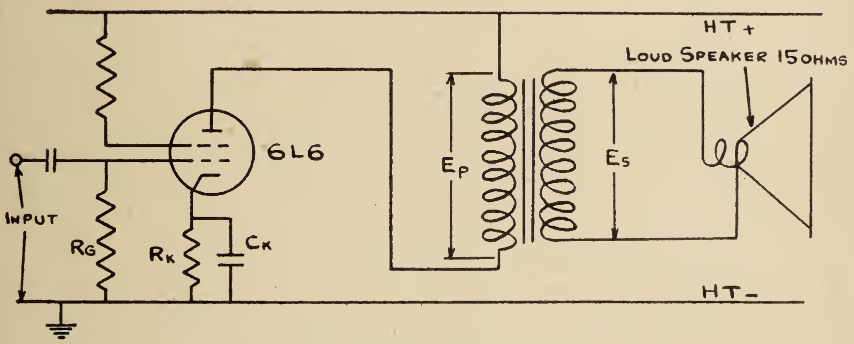

Fig. 3. Loud-speaker Matching.

DISCUSSION

MR. FRASER : Does acoustic watts indicate actual output, and what is the difference between electrical and acoustical watts?

THE AUTHOR : The term acoustic watt indicates the rate at which power or sound is being delivered by the loud-speaker units. Basically there is no difference between the two units—they can both be expressed in fundamental units of ergs per second. The difference lies in the method of production or absorption of the power.

MR. WATSON : In the case of Class A push-pull, there seems to be little difference when operating this stage with one valve removed. What would be the effect in a loud-speaker if one valve were removed in a Class B push-pull stage?

THE AUTHOR : I agree that there is little apparent difference when one valve is removed in a Class A push-pull stage. With regard to Class B, however, the removal of the one valve would result in a great deal of harmonic distortion and the loud-speaker cone would appear to be very much out of centre.

TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library.

SENSITOMETRIC CONTROL OF THE DUPING PROCESS.

J. P. Weiss, *J. Soc. Mot. Pic. Eng.*, Dec., 1946, p. 443.

With normal sensitometric procedures the process of making duplicate negatives cannot be followed in detail sensitometrically as the conditions under which the sensitometric exposures are made differ from those for the picture, head and tail effect being particularly serious. The author describes a form of "print-through" chart which has been used successfully to follow the duping process sensitometrically. M. V. H.

AN IMPROVED METHOD FOR THE DETERMINATION OF HYDROQUINONE AND METOL.

Baumbach, *J. Soc Mot. Pic. Eng.*, Nov., 1946.

The developing agents are extracted by two portions of methyl acetate from the sample saturated with potassium bromide at a pH of 8.0—8.5. The metol is determined by potentiometric titration against N/10 Hce. Subsequently, the sum of the metol and hydroquinone is determined by titration with iodine in the same sample. Greater convenience is claimed and superior accuracy in the case of low pH developers containing little metol. M. V. H.

APPLICATION OF METHYL ETHYL KETONE TO THE ANALYSIS OF DEVELOPERS FOR ELON AND HYDROQUINONE.

Vaughan C. Shaner and Mary R. Sparks. *J. Soc. Mot. Pic. Eng.*, Nov., 1946, p. 409.

The method of determination of metol and hydroquinone described by Baumbach (*see abstract above*), was adapted for the U-tube extractor. Alternative extracting solvents were tried and tests showed methyl ethyl ketone to be superior to methyl acetate. Tests using this solvent show that the method is suitable for routine analyses of production developers. M. V. H.

UNDERWATER PHOTOGRAPHY. PRINCIPLES AND PRACTICE.

Marcel Draby, *Sciences et Ind. Phot.*, Jan., 1947.

After a brief general survey of the problems of underwater photography, the choice of angle of lens and construction of a water-tight camera housing, with joints for controls, is discussed in some detail. Examples are given of the camera housings for a "Leica" and a "Verascope," and of the submersible lamps constructed at the Laboratories du Centre d'Etudes de la Marne. M. V. H.

RAPID TEST FOR FERRICYANIDE BLEACH EXHAUSTION.

L. E. Varden and E. G. Seary, *J. Soc. Mot. Pic. Eng.*, Dec., 1946. p. 450.

A ferricyanide bleach is sensitive to changes in concentration of ferrocyanide. The determination of ferrocyanide in a diluted sample is made by converting it to ferric ferrocyanide ("Prussian Blue") which is determined on a Kodak "Argentometer." M. V. H.

A PROCESSING CONTROL SENSITOMETER.

G. A. Johnson, *J. Soc. Mot. Pic. Eng.*, December, 1946. p. 474.

An intensity scale sensitometer manufactured by Messrs. Eastman Kodak, Ltd. is described. The exposure is modulated in 21 steps of increment $\sqrt{2}$ by means of a step wedge. The lamp is a 10 v. 7.5.A exciter lamp operated at about 6.5A and two set-ups are provided, one suitable for positive type material and the other for negative. Characteristic curves of all types of materials are given. M. V. H.

STUDIO PRODUCTION WITH TWO-COLOUR BIPACK MOTION PICTURE FILM.

J. W. Boyle and B. Berg, *J. Soc. Mot. Pic. Eng.*, February, 1947, p. 111.

Modification of the Mitchell camera for bi-pack involves re-setting lenses and focusing glass, and modification of the pressure plate. Identical perforations must be used for registration in all operations. A key light of 500 foot-candles is used at a lens aperture of *f*/2.8, with coated lenses. The requirements of make-up and colour selection are discussed. R. H. C.

A DE LUXE FILM RECORDING MACHINE.

M. E. Collins, *J. Soc. Mot. Pic. Eng.*, February, 1947, p. 148.

The RCA Type PR-31 recording camera is designed to fulfil all the requirements met with in a "main studio channel" installation. A "folded" optical system is adopted,

having provision for several alternative types of area track, also the density system may be used. Provision is made for adding photo-cell monitoring.

Modifications to the film chamber include the use of spring loaded jockey rollers to maintain film contact with the recording drum, while slating and punching accessories may be permanently installed. N. L.

A NEW BLOOPING DEVICE.

George Lewin, *J. Soc. Mot. Pic. Eng.*, April, 1947, p. 343.

This paper describes a method of automatically silencing the splices on work prints used for re-recording. Holes are punched in the picture area of the sound track by means of a convenient foot-operated punch, at a fixed distance from each splice. These holes then serve to operate a switch in the re-recording head so that the sound output is momentarily cut off, while the splice is passing the scanning beam. AUTHOR'S ABSTRACT.

IMPROVED ENGINEERING DESIGNS FOR STAGE DOORS, TRANSPARENCY SCREENS, AND WATER TANK BULK-HEADS.

A. C. Zoulis, *J. Soc. Mot. Pic. Eng.*, April, 1947, p. 348.

This paper describes three innovations in studio stage construction : (1) Vertical-lift Stage Separation Doors. These doors eliminate the hinged type formerly used, which required so much valuable stage space. Ease of operation and good sound insulation have been obtained between adjacent stages. (2) A Movable 50-foot Transparency Screen. A screen has been suspended from a monorail system for storage outside the stage. It can be readily rolled into position in the space normally occupied by the vertical lift doors to permit large screen transparency shots to be made between connecting stages. (3) A Vertical-Lift Disappearing Bulk-head for a Stage Water Tank. A hydraulically lifted bulk-head has been designed which permits a large sound stage to be quickly converted into a 7 ft. deep tank. AUTHOR'S ABSTRACT.

FREQUENCY ALLOCATION.

Paul J. Larson, *J. Soc. Mot. Pic. Eng.*, March, 1947.

The S.M.P.E. strongly opposed the F.C.C. reallocation of the frequency bands originally reserved in 1945 for theatre television, to other services. In this statement they put forward claims for parity of importance of the needs of theatre television with other non-government demands within the frequency band 1,000—13,000 megacycles. Channe's will be required in the near future within this band for television distribution to groups of kinemas for inter-city relays, and for television pick-up circuits. T. M. C. L.

BRITISH AND AMERICAN STANDARDS

Two British standards specifications of photographic interest have recently been published :

B.S.1383 : 1947. Photo-electric Exposure Meters.—This standard covers photo-electric exposure meters which integrate the light from the subject. It prescribes the scales to be employed and the markings for those scales ; it specifies the effective range for the pointer and the standard of accuracy to be attained, together with a limit of time of response and limits for errors due to fatigue, to tilting, or to change of temperature. Recommendations are made upon methods of calibration and upon acceptance angle.

B.S.1371 : 1947. Microfilm Readers, and Reels.—This standard covers 35 mm. and 16 mm. microfilm, microfilm readers, and reels for processed microfilm. Guidance is given on the arrangement of images and the sequence of pages. (American specifications on the same subject have been recently issued under Nos. Z38.7.9—1946 and Z38.7.17—1946.)

American Specifications.—The following American standards have been recently issued :

Z38.2.1—1946. Method for determining photographic speed and speed number.

Z38.2.4—1946. Method for determining spectral-sensitivity indexes and group numbers for photographic emulsions.

Z38.4.3—1947. Distance scales marked in feet for focusing camera lenses.

Work is proceeding by A.S.A. Committees on standardising sensitometric practice and procedure. A number of American specifications covering a wide range of photographic chemicals have been circulated for ballot.

A trial specification, No. Z38.7.18, relates to lantern slides 5 in. × 4 in. and 2¾ in. × 2¾ in. in size.

EXECUTIVE COMMITTEE

Meeting of August 6, 1947.

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), P. H. Bastie (*Hon. Treasurer*) and R. H. Cricks (*Secretary*).

Elections.—The following were elected:—
Herbert John Morgan (Associate), Granada Theatre, Aylesbury.
Otto Heller (Member), Teddington Studios.
Richard Charles Welch (Student), Radiant Films, Ltd.
George Patrick (Associate), Gaumont Palace, Middlesbrough.

Transfers.—The following Associates were transferred to Membership :—
Percy Newsum, Odeon Theatres, Ltd., Manchester.
Joseph William Davies, Astoria Cinema, Forest Hill.

Reinstatement.—The following was reinstated as a Member :—
James Whitnall, Paignton.

Death.—The death of Raymond Nutton was noted with regret.

Fellowship.—Approval by the Society's Solicitor of draft regulations for the conferment of the Fellowship was noted. Arrangements were made for a meeting of the Fellowship Committee.

Provincial Sections.—The agreement of the Committees of the Newcastle-on-Tyne and Manchester Sections to the draft Branch constitution was reported, exception being taken, however, to the financial provisions. Alternative proposals were made for submission to the Committees.

Home Office Regulations.— A number of Sub-committees was appointed to consider various sections of draft Home Office regulations. The view was strongly expressed that the purpose of the Society must be to assist the Industry and the Authorities.

Membership Certificates.—Arrangements were approved for the printing of certificates of Fellowship, Membership, and Associateship. In view of the heavy cost, it was agreed that a charge should be made for them.

National Illumination Committee.—It was agreed to ask the Illuminating Engineering Society to keep the Society *au fait* with the work of this Committee on kinema and studio illumination.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of the Journal.

E. Richard Eadie has celebrated the fortieth anniversary of his wedding by presenting a cheque for £5 5s. to the funds of the Newcastle-on-Tyne Section.

W. Kelly, on successful termination of the Polytechnic two-year course, has secured a temporary appointment with Denham Laboratories pending his return to Australia.

Donald McMaster, F.R.P.S., and past Deputy Chairman of Kodak, Ltd., London, has returned to New York to take up his new post as Vice-President and Assistant General Manager to the Eastman Kodak Company.

Norman Parkinson is recovering from an internal operation.

J. A. Walters has been appointed Manager of the General Electric Company's Carbon Department.

K. C. Wiles, of Leevers Rich & Co., is shortly leaving for Vancouver to take up a technical position.

Julian Wintle, after a protracted illness, is directing for A.K.C.

BRITISH KINEMATOGRAPHY

The Journal of the British Kinematograph Society

VOLUME ELEVEN, No. 4. OCTOBER, 1947

THE FELLOWSHIP

The Council is happy to announce that it has accepted the recommendations of the Fellowship Committee, arrived at after many protracted meetings, for the conferment of the Fellowship. The regulations set out overleaf, which have been approved by the Society's Solicitor, Mr. H. Barrs Davies, have been confirmed.

By ballot of the membership, the following 15 Members were on November 13th, 1946, elected as the original Fellows :

Messrs.

I. D. Wratten	P. G. A. H. Voigt
A. G. D. West	G. Parr
R. H. Cricks	L. Knopp
W. M. Harcourt	G. B. Harrison
P. H. Bastie	W. Buckstone
C. H. Champion	J. C. Cabirol
E. Oram	R. R. E. Pulman
A. W. Watkins	

These 15 Fellows have constituted the Fellowship Committee which has prepared the new regulations. At their latest meeting, held on September 10th, 1947, the regulations were formally recommended for confirmation to the Council.

In accordance with these regulations, the Committee is empowered to recommend for the Fellowship, without further enquiry, any of those Members who were nominated in the initial ballot, but were not elected. Under standing orders prepared by the Committee, elections are required to be by secret ballot, and two dissentients disqualify an applicant. The necessary degree of unanimity was secured only in the case of one Member, Mr. Rex B. Hartley, whose services to the Industry and to the Society the Council is pleased to recognise by conferment of the Fellowship.

The Council has also accepted the recommendation that the Honorary Fellowship be conferred upon the following in recognition of their invaluable services to the Industry :

Messrs. P. H. Bastie (*Hon. Treasurer*),
A. G. D. West, M.A., B.Sc., F.R.P.S. (*Past President*).

The Council further announces that nominations or applications for the conferment of the Fellowship may be submitted on forms shortly to be obtainable from the Secretary. Completed forms must be received not later than March 1st, 1948, if they are to be considered during the coming year. The attention of intending nominators or applicants is drawn to the need for strict adherence to the regulations, and to the standing orders, as set out on the nomination form.

REGULATIONS FOR CONFERMENT OF FELLOWSHIP

1. The Fellowship may be conferred upon any person not under 35 years of age, who, save in the exercise of the special discretion of the Council, shall for a period of not less than five years have been a Corporate Member of the Society (Active Membership in the unregistered Society to count in the qualifying period) and who shall comply with the following requirements:

(i) He shall either—

(*a*) in the opinion of the Council have reached a position of distinction and eminence in, or by research and invention have materially advanced, the science or art of kinematography or subjects pertaining thereto ; or

(*b*) be recommended to the Council by not less than five Corporate Members as a person who has reached a position of eminence in the science or art of kinematography or subjects pertaining thereto.

(ii) He shall have delivered to the Society to the satisfaction of the Council a thesis, lecture, or demonstration upon the subject in which he has gained eminence, or upon which he has conducted research.

2. Any person who was duly nominated for the initial ballot for the election of Fellows may be elected without further enquiry into his qualifications.

3. Except in special circumstances, not more than five Members shall be admitted to the Fellowship in any one year.

4. Nominations to the Fellowship shall be considered by the Fellowship Committee which shall be appointed annually by the Council from among the Fellows and Honorary Fellows, and shall submit its recommendations to the Council for ratification.

5. A Fellow shall pay an annual subscription of Three and a half Guineas.

NOTIFICATION OF MEETINGS

Members are reminded that the programme cards formerly issued, giving the entire lecture programme for the session, will no longer be published. The lecture programme which was included in the September issue should therefore be kept available for reference.

This and future issues of *British Kinematography* will contain programme cards which are being used as substitutes for the former postcards, now discontinued.

Non-members desiring to attend meetings in future can only do so by the presentation of an invitation card which must be signed by a Member or an Associate. An invitation will be found attached to the monthly programme card, which may be completed and handed to any interested non-member. Additional cards may be obtained on application to the Secretary, from whom non-members may also obtain invitations.

B.K.S. DINNER

The Social Committee has regretfully decided that, owing to the recently imposed restrictions, the Dinner and Dance provisionally arranged for December 3rd. must be postponed.

It is hoped that it may be held at a later date, as soon as conditions permit.

COLOUR MODIFIED COMPACT SOURCE LAMPS FOR FILM AND TELEVISION

H. K. Bourne, M.Sc., M.I.E.E., F.R.P.S.* and E. J. G. Beeson*

Read to a joint meeting of the Royal Photographic Society with the British Kinematograph Society, on 25th March, 1947.

THE film industry is perhaps the largest consumer of high power lamps due to its special requirements. Tungsten filament lamps, in sizes up to 10 kW. and mounted in spotlights or open reflectors, are used extensively in film studios for black-and-white film production. The advent of colour photography resulted in a requirement for illumination levels of 750 ft.-candles upwards, levels which can only be provided over a large area by high intensity carbon arcs rated at 40 to 150 A. mounted in "broads" and "spots."

Studio lighting engineers have realised for some years that high pressure mercury vapour lamps offered possibilities, but two reasons have prevented their adoption. The colour rendering given by the earlier lamps was not sufficiently good for colour photography, and the delay in obtaining full light output has in the past made them unsuitable for use in studio and kinema conditions. Recently these two difficulties have been overcome, with the result that the aspect has changed, and it is probable that the new instant starting colour modified compact source lamp will play an important part in the future in the film industry.

Construction of Compact Source Lamps

The compact source, or type ME lamp, consists essentially of an approximately spherical quartz bulb containing near its centre two tungsten electrodes spaced a few millimetres apart between which the arc operates[1]. The current-carrying molybdenum foil seals may emerge either diametrically opposite to one another, as in the double ended lamp shown in Fig. 1, or from one side of the bulb as in Fig. 2. The diameter of the bulb increases as the wattage increases, so that the surface area is sufficient to prevent the temperature of the quartz exceeding about 700° C. The bulb contains a filling of a starting gas and a globule of mercury or of mercury-cadmium, which evaporates completely during normal operation of the lamp and exerts a vapour pressure of 10 to 40 atmospheres in the bulb.[2]

The electrodes consist of blocks of tungsten with ends chamfered to give minimum obscuration of the arc. Lamps intended for A.C. operation have symmetrical electrodes, but in D.C. lamps the anode must be made larger than the cathode owing to the greater heat dissipation at the former electrode.

The largest practical lamps made at present take a current of 150-A and are rated at 10 kW. Experimental 20 kW. lamps have also been made.

Electrical Characteristics

The voltage drop in the lamp is generally 65 to 80v. and the lamps will operate from a 100-115v. supply. A 5 kW. lamp takes a current of 75 A. with a total power consumption from a 115v. supply of 8.65 kW. This may be compared with the arc in an MR.65 studio spotlight consuming 65 A. at 58v., where the power in the arc is 3.8 kW. and that from the supply is 7.5 kW.

When a cold lamp is first switched on, the voltage drop across it is only about 15v. so that the starting current will be considerably higher than the

* Research Laboratory, British Thomson-Houston Co., Ltd.

Fig. 1. *Experimental 10 kW. double-ended Compact Source Lamp.*

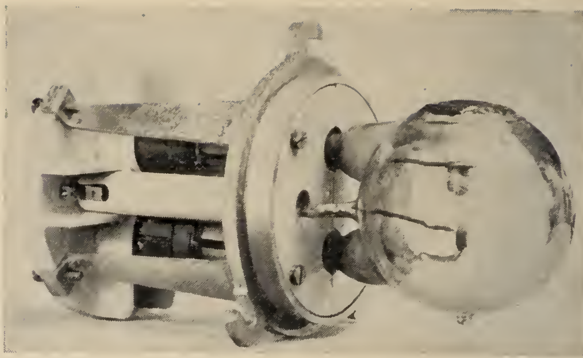

Fig. 2. *Experimental 5 kW. single-ended Compact Source Lamp.*

normal running current. The starting current may be limited by an extra starting resistance.

It will be appreciated that in the compact source lamp, the light is produced by the arc itself, while in the carbon arc it is emitted chiefly from the positive carbon crater. The length of the arc in a type ME lamp varies from 6 mm. in a 1000 W. lamp to 11 mm. in a 10 kW. lamp, while its width is generally somewhat less than its length. Curves of brightness distribution over the arc of a 5 kW. lamp are shown in Fig. 5. Data on the source size of compact source lamps are given in Table I. Extremely high values of brightness, far exceeding those obtainable from carbon arcs, have been obtained from experimental compact source lamps[3].

Spectral Energy Distribution

Light is produced by a discharge in gas as a result of transitions of excited atoms from one excited state to another at a lower energy level. Each transition produces radiation of a certain wavelength, and the nature of the gas and the operating conditions can be chosen so that the radiated lines lie in the visible spectrum, and the discharge is an efficient light generator.

The chief lines in the spectrum of a discharge in mercury vapour at a high pressure lie at wavelengths of 5770/90Å (yellow), 5461Å (green), 4359 and 4047Å (blue) and 3650Å (ultra-violet). A small amount of continuum

TABLE I.
DATA ON COMPACT SOURCE LAMPS

Lamp rating W.	250	500	1000	2500	5000	10000
Lamp voltage V.	60—75	60—75	60—75	65—80	65—80	65—80
Lamp current approx. A. ...	4	8	15	37	75	150
Arc length mm.	3.75	5	6	7	10	10
Effective arc width mm. ...	1.5	2	2.5	5	7.5	8.5
Bulb diameter mm. ...	51*	65*	45	65	85	120
Overall consumption from 115v. D.C. supply W. ...	460	920	1725	4260	8650	17300

* Diameter of outer glass jacket

is also present, the amount of which increases with increasing wattage loading per unit length of arc column. Owing to the low red content in the radiation, the colour rendering particularly of red objects illuminated by the lamp is distorted seriously. The red content rises as the loading increases, but even at the highest loadings the deficiency is still marked and the colour rendering of a normal mercury lamp is unsatisfactory for colour photography.

The colour of the discharge from mercury vapour may be improved by introducing cadmium into the lamp[4]. Certain other metals may also be used but the strong red line from a discharge in cadmium vapour at 6438Å improves the red content considerably, while the additional blue-green line at 5086Å fills in a wide gap between the blue and the green mercury lines. Other metals have also been tried but the best practical results are obtained with cadmium.

The luminous efficiency of the discharge in cadmium vapour is high at the higher pressure and the high current density in compact source lamps of several kilowatts rating, and so the introduction of cadmium improves the colour without appreciable loss of efficiency.

The colour of the radiation from a lamp is often measured by subdividing the spectrum into a number of bands and measuring the light output or energy in each of these[5]. In sources giving a continuous spectrum the colour may conveniently be specified in terms of colour temperature, but this method may not be used with sources giving a discontinuous spectrum. Figures in Table II show that the red content of a 5 kW. mercury cadmium compact source lamp is 11% as compared with 6% for a normal mercury lamp of the same rating, with a loss in efficiency of only some 5%.

The distribution of energy in the spectrum of 5 kW. mercury and mercury cadmium compact source lamps may be compared by the diagrams in Figs. 3 and 4. Practical tests have proved that high power mercury-cadmium lamps will give a good rendering with various colour photographic processes.

Although the efficiency of production of short wavelength ultra-violet energy is low at the high operating pressure in a compact source lamp, nevertheless the total output is considerable from high power lamps. Precautions must therefore be taken to protect personnel, and lamps should never be operated with the doors of the lamp housing open.

Delay Time

The liquid mercury in the lamp evaporates completely under normal

TABLE II.

RED CONTENT OF LIGHT SOURCES

Expressed by measuring amount of light transmitted by No. 25 Wratten filter.

Light Source	Luminous Efficiency L. per W.	% Red
Sunlight	—	15
200 W. general service tungsten filament lamp.	13.6	25
High intensity carbon arc	31	15
400 W. type MA high pressure mercury vapour lamp ...	45	1
Ditto. with cadmium ...	30	4
" " " " " ...	23	5.5
125 W. type MB quartz h.p. mercury vapour lamp ...	40	2
1000 W. type MD/H watercooled lamp	62.5	4
250 W. type ME compact source lamp	45	3
5000 W. " " "	52	5.5
5000 W. " " " with cadmium ...	50	11.5

operating conditions and within 5 to 10 minutes exerts a pressure of between 10 and 40 atmospheres in the bulb. When a lamp has been operating normally and the arc is extinguished the arc will not ignite again immediately as the re-ignition voltage in the de-ionised vapour is many thousands of volts. The lamp must cool down until the pressure falls sufficiently to enable the arc to re-ignite.

Obviously these delays, while of little importance in some applications, cannot be tolerated in film studios or kinemas, but fortunately they can be avoided in two ways[6]. In the first method, the lamp is mounted in a glass walled oven containing heaters above and below the bulb to maintain the temperature at its normal value of about 700° C. even though the arc is extinguished. Light may be obtained immediately by applying a high voltage impulse of about 15 kV. between an auxiliary electrode and the adjacent cathode. This impulse, which is produced by the discharge of condensers through the primary of a step-up transformer, ignites first the auxiliary and then the main arc.

In an alternative method of arc ignition, avoiding the need for an auxiliary electrode, a high voltage impulse of 30 to 50 kV. is applied directly across the main electrodes of the lamp. When the arc has ignited, the heaters in the oven are disconnected automatically to prevent overheating of the lamp

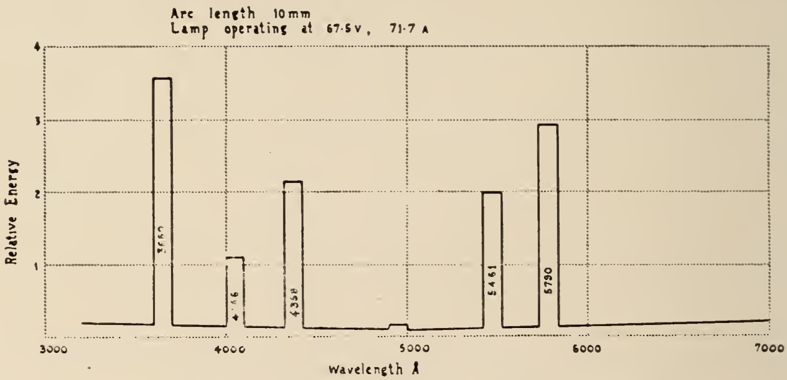

Fig. 3. Energy Distribution of 5 kW. mercury vapour Compact Source Lamp.

With this method of operation the only delay remaining is the initial warming up period of 15 minutes at the beginning of each day, after which full light output can be obtained immediately at any time. The power used in the heating oven for a 5 kW. lamp is approximately 2 kW. The photograph in Fig. 6 shows an experimental arrangement of this type fitted in an MR. 90 housing. The impulse starting unit is contained in the box underneath the housing.

Another method of operation utilises the principle of "simmering"[7] After the lamp has warmed up, the current in it is reduced to about 15% of its full load value and the shutter is closed. The casing also contains a heating spiral surrounding the lamp, and the total dissipation in this heater and in the lamp is sufficient to maintain the bulb at the normal operating temperature with the lamp simmering. When the light is required the lamp power is increased to full load, and the shutter is opened simultaneously. The heating spiral is connected in series with the lamp to form the simmering resistance ; in this way the heat dissipated in the simmering resistance helps to maintain the temperature of the bulb.

An experimental simmering unit is shown in Fig. 7. The shutter actuating mechanism is linked mechanically with the simmering resistance short

circuiting switch. The power consumption in the simmering condition is approximately 1.5 kW. in this unit, which operates from 115v. D.C.

Either of these methods may be used, but a third possibility is to combine the principle of simmering with the high voltage impulse method of arc re-ignition.

Operating Position

When a lamp is tilted, convection currents carry the arc flame vertically upwards which may cause overheating of the bulb where it impinges on the quartz, leading to premature failure of the lamp. The difficulty may be avoided by dispersing the arc flame before it touches the quartz. By applying a suitable magnetic field, the arc flame can be deflected downwards against the action of the convection currents whatever the angle of tilt of the lamp, to enable the lamp to be operated in any position. For upward tilt, a magnetic field must be brought into action to disperse the arc flame. In a double ended lamp a magnetic field is required for either upward or downward tilt.

The magnetic field is generally produced by a solenoid connected in series with the lamp. This may have a movable iron core by which the field intensity may be varied in accordance with the burning position of the lamp.

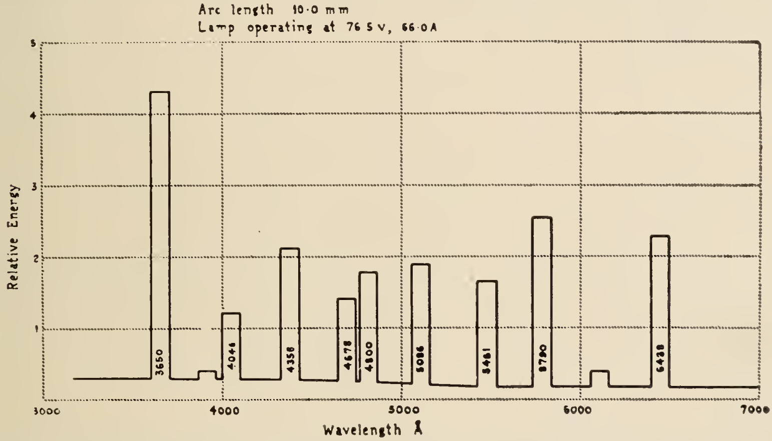

Fig. 4. Energy Distribution of 5 kW. mercury-cadmium vapour Compact Source Lamp.

The position of the core is moved by the action of gravity when the lamp is tilted so that operation is automatic. A device of this type may be seen fitted to the unit in Fig. 7.

Stroboscopic Effect

When a discharge lamp is operated on A.C., the current falls periodically to zero and the light output thus fluctuates in accordance with the change in current. This cyclic fluctuation in light intensity can cause difficulties when the lamps are used for photographic applications. With a 50 c.p.s. supply variations in exposure occur with exposure times shorter than 1/50 sec. In kinephotography or kine-projection, stroboscopic effects will be produced which cause fluctuations in screen intensity unless the supply frequency synchronises with the frame frequency.

In film applications stroboscopic effects may be avoided by operating the lamps on D.C. and the reduced overall efficiency in this case must be accepted.

Constancy of Light Output

A sudden reduction in supply voltage of 1% will reduce the light output

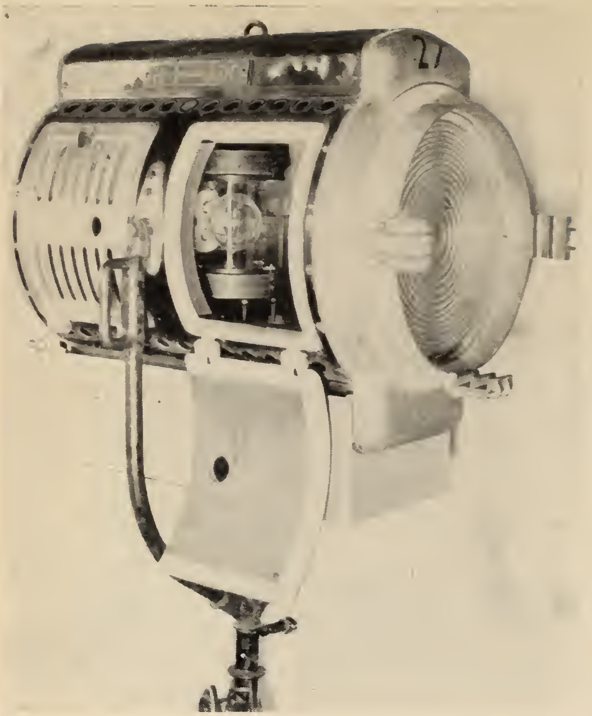

Fig. 6. *Studio Spotlight fitted with 5 kW. Compact Source Lamp and instant start Circuit.*

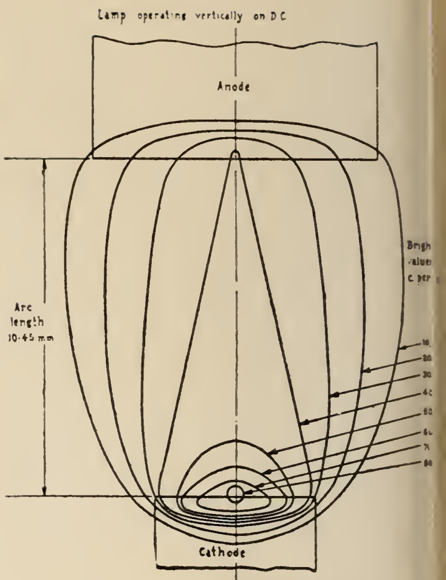

Fig. 5. *Brightness Distribution in the Arc of a 5 kW. Compact Source Lamp.*

from a mercury cadmium lamp by about 3.4%, but will have very little effect on the colour of the radiation. The spot produced by a compact source lamp in a spotlight is perfectly steady and clean cut.

Complete life test data for high power compact source lamps operating under service conditions are not yet available, but it is expected that lives of some hundreds of hours should be obtained. The light output in this class of lamp at the end of its normal life is generally about 75% of its initial value.

Cleanliness

With the arc hermetically sealed in the quartz envelope, the compact source lamp is perfectly clean in operation, and produces no smoke, fumes or dust. The maintenance of units for cleaning is consequently reduced and the haze of smoke, which sometimes envelops studios in which a number of arcs are operating, is avoided entirely.

Fire risk is less and the absence of fumes reduces the load on the air conditioning plant.

Safety Precautions

The application of compact source lamps may necessitate the adoption of certain safety precautions which have not so far been required in film studios. Presumably housings fitted with high voltage impulse circuits for restriking will have to be earthed.

It will be necessary to ensure that the doors of a housing cannot be opened when a lamp is operating or the circuit is alive, both to protect personnel from the ultra-violet radiation from a bare lamp, and to safeguard against the possibility of an explosion of the bulb. Such explosions are extremely rare, but if they do occur they are extremely violent, so that lamps should never be operated except in an enclosure. Lenses have occasionally been broken by a lamp bursting, and it is therefore a wise precaution to place a wire netting screen over the condenser to prevent pieces of glass falling from overhead spots if such an event does occur.

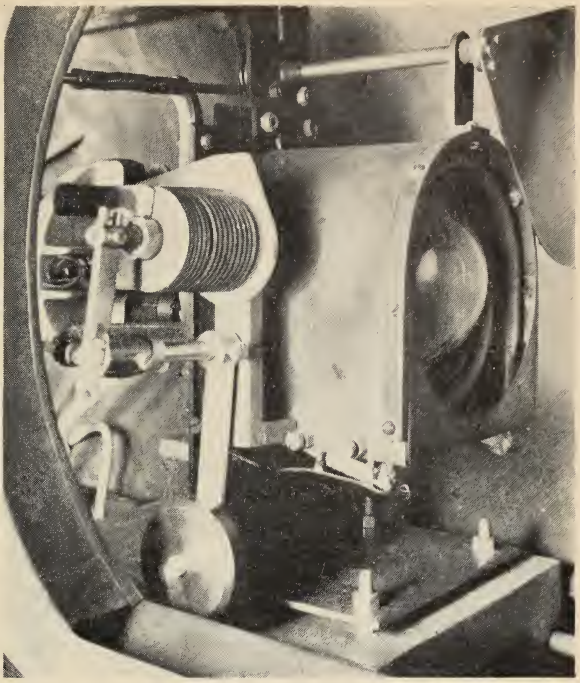

Fig. 7 Arrangement of Simmering Oven for Compact Source Lamp in Spotlight.

Dimming

Normally, a high pressure mercury vapour lamp cannot be dimmed satisfactorily over a wide range without causing unstable operation. When the current is reduced the light output drops immediately, but owing to the reduction in lamp wattage, the temperature of the bulb falls and some of the mercury condenses, causing a reduction in lamp voltage and a further fall in lamp wattage.

It should, however, be possible to design a lamp unit which can be dimmed satisfactorily over a wide range of light intensities by providing a heater around the lamp to maintain the temperature of the bulb at all values of current.

Heating

A quartz high pressure mercury vapour lamp radiates only about 11% of its input energy as light. Some 15% appears as infra-red radiation, as compared with 60 to 70% from a tungsten filament lamp of equal wattage, so that the heating of objects illuminated by the discharge lamp is much less. Comparative tests of the temperature rise of the human skin when illuminated by compact source lamps, carbon arcs, and tungsten filament lamps shows that for a temperature rise in the skin of approximately 2° C., for example, the relative levels of illumination with these three forms of illumination are 1320, 2640 and 5280 fC. respectively. The reduction in heating is a factor of considerable significance in film studios owing to the high levels of illumination of around 1000 fC., and one which will help to improve the conditions for the artists[9].

Actinic Value

Due to the high output of radiation in the blue region, the mercury vapour lamp is very effective as a photographic light source, particularly with blue-sensitive and orthochromatic emulsions.[10] Comparative figures in Table III show the relative actinic efficiencies of compact source and tungsten filament lamps with various emulsions.

Applications of Compact Source Lamps : (*a*) Film Studios

The first practical tests with colour modified compact source lamps were carried out in conjunction with F. V. Hauser and Messrs. Technicolor, Ltd. Tests at Denham Studios in May, 1945, in which colour charts were photographed in Technicolor, proved that a good colour rendering could be obtained with illumination from a 5 kW. mercury cadmium lamp. Tests were continued on a larger scale in November, 1945, when a small set was illuminated first with seven 5 kW. mercury-cadmium compact source lamps in converted MR. 65 spotlight housings, and then with the same number of 65 amp. H.I. carbon arcs[6]. A Technicolor film made under the two types of illumina-

tion showed that there was little to choose between them as regards colour rendering.

Sections of these tests were projected showing excellent colour rendering.

Recent tests with Kodachrome, Dufaycolour and Anscocolor, show that mercury cadmium lamps can give excellent results with these materials. These experiments have established that the compact source mercury-cadmium lamp is already a useful source for film studio illumination, and several studios in this country are now installing a relatively large number of lamps to gain experience in film production.

(*b*) Television Studios

The general principles of television studio lighting are similar to those in film studios, except for a few important differences. So far, tungsten filament spotlights have been used generally in Great Britain, but satisfactory results with water cooled mercury vapour lamps have been reported from the U.S.A.

The combination of camera and mercury cadmium lamp enables a good match to be obtained and gives an improved rendering of colours into monochrome. The advantages of the discharge lamp as regards heating have already been described and artists performing under the discharge lamp units invariably comment on the " coldness " of the light.

Practical tests were first made in this country with the mercury-cadmium compact source lamp at the B.B.C. Television Station at Alexandra Palace, where a set was lighted with five 5 kW. lamps mounted in converted MR.90 housings.

(c) Film Projection

Compact source lamps can obviously be applied for film projection as a replacement for either the carbon arc or the incandescent lamp.

Experiments made some years ago in B.T.H. 35 mm. projectors with 2½ kW. compact source lamps have been attended with considerable success. Technicolor films have been projected with this lamp and with a carbon arc before an audience who found it difficult to differentiate between the two sources as regards colour rendering. In kinema projectors, it will be necessary to use the principle of simmering, and to keep a spare lamp heated continuously, in order to protect completely against possible delays. The problem of applying these lamps to large projectors for kinemas is largely one of economics.

The compact source lamp is likely to be used at first in smaller projectors, either portable 35 mm. equipments previously fitted with incandescent

TABLE III.

Relative Photographic Effectiveness of Compact Source and Tungsten Filament Projector Lamps.

Photographic Material	Relative photographic speed.	
	For equal visual illumination	For equal total power consumption
Panchromatic film	1.1	2.2
Orthochromatic film	1.7	3.3
Positive film	4.4	8.5
Bromide paper	6.9	13.7
Gaslight paper	3.5	8.3

lamps, or in 16 mm. projectors. Tests made with a 750 W. compact source lamp in a 16 mm. projector have enabled a flux of 1000 L. to be directed on to the screen, as compared with approximately 300 L. for a tungsten lamp of equal power.

(*d*) Film Printing

Another important application of the compact source lamp in the film industry, is as a source for film printing[11]. A number of printing machines have been fitted with the 250 w. compact source lamp, with the result that the printing speed has been increased considerably, and that slow emulsions can be printed without sacrifice of printing speed. As the light output of the lamp cannot be varied over wide limits, the lamp is suitable for those machines fitted with aperture control of exposure.

Acknowledgments

The authors wish to acknowledge with thanks the help given by their colleagues in the Research Laboratory of the B.T.H. Co. They also wish to thank Mr. F. V. Hauser of Denham and Pinewood Studios ; Messrs. Hewitt and Double ; Mr. W. Norris, of Archibald Nettlefold Studios ; and Messrs. Macnamara, D. R. Campbell, and other B.B.C. engineers for their valuable assistance, and for providing facilities for carrying out the practical tests. Finally, thanks are also due to Mr. L. J. Davies, Director of Research of the B.T.H. Company, for permission to publish the paper.

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DISCUSSION

Mr. J. P. J. Chapman : Is it likely that a lamp can be produced which can be worked on 3-phase A.C. to obviate the cost of having expensive D.C. conversion equipment ?

Mr. Bourne : Lamps operating from 3-phase A.C. have been made experimentally, but they are rather complicated.

Mr. S. Double : There must be an earthing lead to these units and it must be so arranged that unless the earthing connection is connected it is impossible to strike up the lamp. A switch must enable the condensers to be discharged.

Mr. Bourne : It is not necessary to use earthing on standard studio lighting fittings,

because they use only 110 volts. But if there are to be fittings with an impulse of some thousands of volts, a shock from a lamp when on the rails might prove dangerous. The question as to whether earthing will be essential is being investigated.

Mr. R. H. Cricks : Has the lamp proved sufficiently stable for sound printing, and can it be dimmed for picture printing?

Mr. Bourne : I do not think the lamp has been tried for picture printing. It is not normally capable of being dimmed. I do not think the lamps have been tried for sound printing, but they are quite stable.

Mr. L. V. Chilton : Is it possible,because of the greater efficiency of these lamps over incandescent lamps, to use finer grain and therefore slower stock?

Mr. Bourne : Certainly, these lamps are enabling fine grain emulsions to be printed without any sacrifice in printing speed.

Mr. F. V. Hauser : I expect this lamp will have a very big effect on motion-picture photography, particularly for colour. Tests have proved that the mercury cadmium lamp is equally suitable for colour photography as is the arc lamp.

Mr. W. Norris : It is possible to run a lamp for as long as 7 hours, switching on and off, and get the same lumens output at any stage. The arc lamp has been used within 2 ft. of the microphone and there has been no trouble with noise. The weight of the complete unit is much less than that of an arc and it is easy to keep clean.

Mr. F. Critoph : Has the lamp been demonstrated in a kinema?

Mr. Bourne : Demonstrations have been given in a small kinema in 35 mm. projection, and about equal light output or a little more from the mercury lamp than from the carbon arc for equal power, has been obtained.

Mr. S. Double : Is there any serious risk of an explosion with the lamp?

Mr. Bourne : It is necessary to warn people against the possibility of an explosion, because of the high pressure. When a bulb explodes with 20 atmospheres inside, it is like a small bomb and the quartz is red-hot. Explosions are very rare ; but if the control gear broke down and some one operated it incorrectly a lamp might explode. Compact source lamps should be operated inside a protective housing.

BOOK REVIEWS

KINEMATOGRAPH YEAR BOOK, 1947. *Kinematograph Publications, Ltd.* 20*s.*

The reputation of the Kinematograph Year Book as an invaluable guide to the film industry is well maintained in the 1947 issue, just published.

The 600 pages contain data of a general and technical nature, of value to all branches of the trade. There is the usual review of trade developments last year ; biographies of leading personalities ; studio facts and figures, labour and technical developments ; a directory of kinemas ; and overseas markets.

Mr. Norman Hart, C.E.A. solicitor, contributes an article on the legal outlook and the summaries of the various Acts governing the trade are most helpful. The financial section gives the directorate, capital and share price record of leading companies.

In view of expansion of 16 mm. markets, the section giving names of renters and exhibitors should prove most valuable.

J.C.W

THE PRESENTATION OF FILMS, 16 *pages, price* 2*s.* 3*d. post free* ; *FILM PRODUCTION,* 14 *pages, price* 2*s.* 3*d. post free* ; *WOMEN TALKING,* 29 *pages, price* 3*s.* 3*d. post free* ; *published by the Kinematograph Section of the Royal Photographic Society of Great Britain,* 16, *Prince's Gate, S.W.*7.

These three interesting brochures contain useful information on kinematography not usually found in text books.

THE PRESENTATION OF FILMS provides a comprehensive survey of the essentials for non-theatrical projection, itemising the observances required by safety regulations.

The provision of adequate seating accommodation, ventilation, illumination, sound and projection, occupy a considerable portion of the booklet and advice is given on licensing and the care of films and the projector.

FILM PRODUCTION is mostly concerned with organisation and personne of film societies, the preparation of script and the importance of editing and titling.

WOMEN TALKING. This brochure is a report of a symposium by women technicians on their part in film production. Script writing, continuity and art direction are discussed from the woman's point of view.

THE PRODUCTION OF CARTOON FILMS

David Hand*

Read to the British Kinematograph Society on March 12th, 1947.

THIS paper is divided into two sections: the first an account of the studios and their organisation; secondly, the development of a cartoon sequence from the original story idea, through production routine, to its inclusion in a finished film.

The administrative department is closely related to every stage of production. The functions of this department include, among other things, the provision of equipment and materials. It must designate the type of story and budget the overall cost of the picture along with separate budgets for each of the many production operations. It assumes the responsibility of watching weekly costs of the various departments so that it can uncover any production weaknesses evidenced by over-expenditures. It is also concerned with the recruitment of staff, and in particular the attracting of artists who are likely to develop an ability for the work.

The Development of the Cartoon

No written script is prepared for a cartoon film. The script is always in graphic form—many drawings which describe the action, arranged in sequence, and continually revised, until the complete idea is finally approved for production. As an average, an individual drawing corresponds to about 8 ft. of film, although sometimes it may be necessary to draw half-a-dozen pictures for ten feet of film, while on the other hand, a single picture may sometimes cover 20 ft. or 30 ft.

Each story board consists of about 60 drawings, and a complete cartoon might comprise three or four boards.

The usual method of developing a story is to assign a basic idea to two artists, who stimulate each other in developing their "gags," until a single sequence is eventually completed.

When the whole story is finally approved, it is handed to the director. He is the co-ordinator of all the departments, and is responsible from the inception of the story until the picture is finally screened.

*G-B Animation Ltd.

Fig. 1. Part of Picture Board, on which the story of a Cartoon is presented in the form of Sketches.

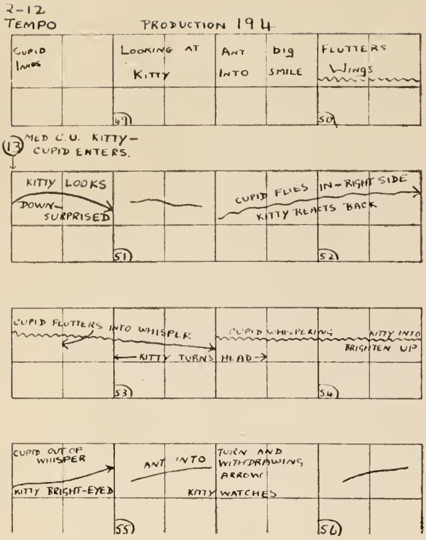


Fig. 2. *Section of Work Sheet. The figures represent feet of Film.*

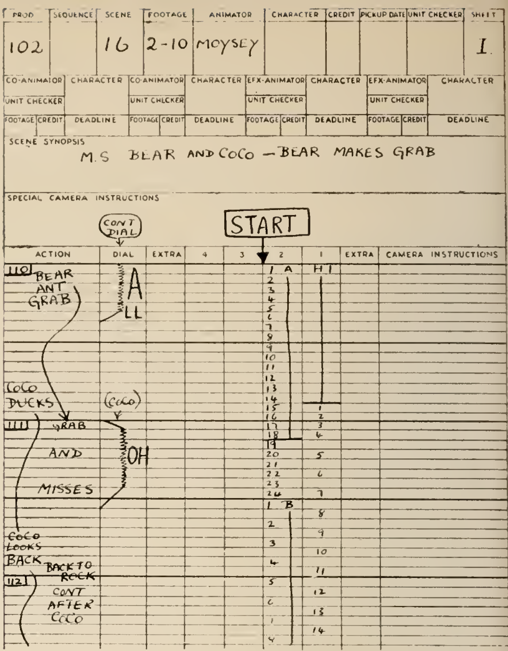


Fig. 3. *A typical Exposure Sheet.*

Before the story goes to the director it may be pre-scored. Dialogue must always be pre-scored, and in this case a chart is prepared for the director, which shows frame by frame timing of vowels, consonants, inflections, and modulations of the voice. Music need not be pre-scored, and it is possible to complete a picture without any music having been composed, thanks to the mechanical means used for timing and synchronising the music. A musical production, which must synchronise with the cartoon action, *e.g.*, dancing, should be pre-scored.

Musical Sequence

The director must at that time decide the tempo of the picture. The setting of the tempo is done by an understanding of music and treatment. The music beat must fit the picture tempo, whether it be, say, two beats to the second (known as "Two twelves," since there are 24 frames to the second), three to a second, with a beat every eight frames, or otherwise. Generally, a picture will start in slow tempo and increase speed towards the end.

Having decided the tempo, the director times every foot of action throughout the film. He has for this purpose a work-sheet : a chart into which is written a description of the action for each foot of film. The chart is divided into squares, which in the case of 2/12 timing, will each represent twelve frames. Each square is numbered, and these numbers are given to the composer of the music, who numbers each bar of music to correspond.

Next, the director makes out an exposure sheet, which is the "bible" for the animator and everybody else concerned with the picture. On this are lines which allow for the indicating of the individual drawings ; each line re-

Fig. 4. *Model Sheet showing features of Cartoon Character.*

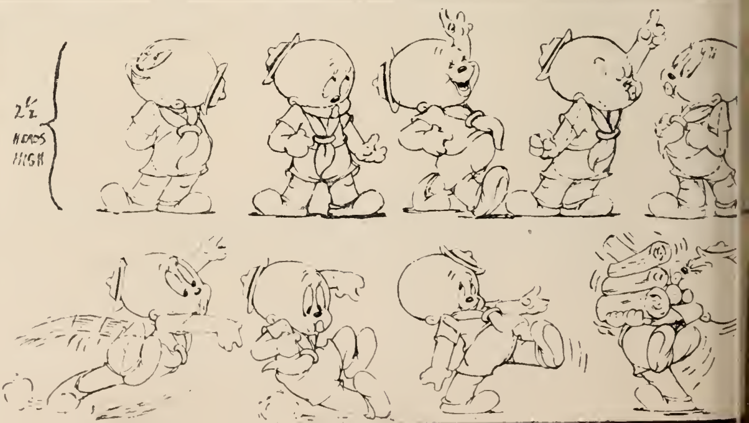


Fig. 5. Progress of an Individual Drawing. Lay-out sketch ; Drawing ready for Film Test ; and Drawing inked in and painted.

presents 1/24th second, or one frame of film. Columns show the " cell level "—the position of a particular celluloid in photographing. On this chart, each drawing is numbered, and in exposure the camera operator places the drawings where the animator has numbered them. Drawings are registered on all drawing-boards, and on the camera, by means of holes fitting on standard pegs.

Lay-out Technique

The lay-out man starts with thumb-nail sketches, which he subsequently draws to full size. Consecutive lay-out action sketches will show the positions of the characters in various portions of the scene. The normal " field " of the camera is 10 in. by $7\frac{1}{4}$ in. ; while shooting, the camera may be moved closer to the drawing, so restricting the area of the " field."

The director delivers the lay-out and exposure sheet to the animator, who will create the movements of the characters. The length of time which it would take a single animator to produce a complete film would be too long, and so a group of animators must be employed. One director can supply one or two lay-out men and about five animators, and this therefore, is the basis for the total number of artists in a production unit.

These five animators would tend to produce five different types of characters. To prevent this, model sheets are prepared, showing a character in various positions, and showing also the exact relation of the head and body, the placement of the eyes, and other features. The great art of the animator is not simply to be able to draw the character correctly, nor even to be able to make him move, but to make him *live*.

The animator makes the extreme drawings of the action, and his assistant and " in-betweeners " make the break-down drawings. Each animator makes an average of one in five of the key drawings. For each key drawing the animator makes a chart showing the spacing between successive drawings.

Animation

At this stage, the individual drawings are filmed and projected as a test. The negative itself is projected, often in the form of a loop. The animator

Background sketch, showing the full Camera Field ... smaller Field after tracking up.

Fig. 7. Finished background drawing.

Fig. 8. An idea gets changed in course of development.

may revise his animation as many as five or six times before the scene is finally approved by the director.

A series of test films, showing the successive modifications, some almost imperceptible, was projected.

Another type of animator is the effects animator, who makes splashes of water, puffs of smoke, and similar effects.

When the test film has been finally approved, the drawings are passed to the inking and painting departments, first passing through a checking department to be sure that the drawings are in proper level (a drawing must be kept at a constant celluloid level, to avoid changes in colour saturation). The colour of the character must be decided ; the colouring must for instance, be changed between sunlight and moonlight.

Pre-camera Work

The girls in the inking department trace the drawings upon transparent celluloid sheets, ·005 in. thick. The background is of course, drawn only once, and the only opaque section of the celluloid is the character. After the background has been rendered and the celluloids have been inked and painted, the complete set moves into the camera department.

Although the drawings are to be photographed in Technicolor, a single-film camera with appropriate colour filters is used ; three frames are exposed on each drawing. Light is provided by spotlights ; a glass frame holds the celluloids flat against the background.

Sound Sequence

Sound sequences must be recorded, checked, and approved : for this the director is responsible. When the picture tests are completed, the dialogue track is run with the test. At this stage the director calls in the musician ; he sees the test reel, he has the work sheets describing the action. He makes a rough composition for the picture, always in the tempo that has been decided upon. A piano track may be made and run in synchronism. Eventually, the score is approved, and is then orchestrated

Recording of Tracks

In recording the final track, the conductor wears 'phones on which he hears the pre-determined beat, so assuring perfect synchronism between picture and sound.

The process of dubbing requires great care. There are the dialogue track,

Fig. 9. Frames from the finished Film.

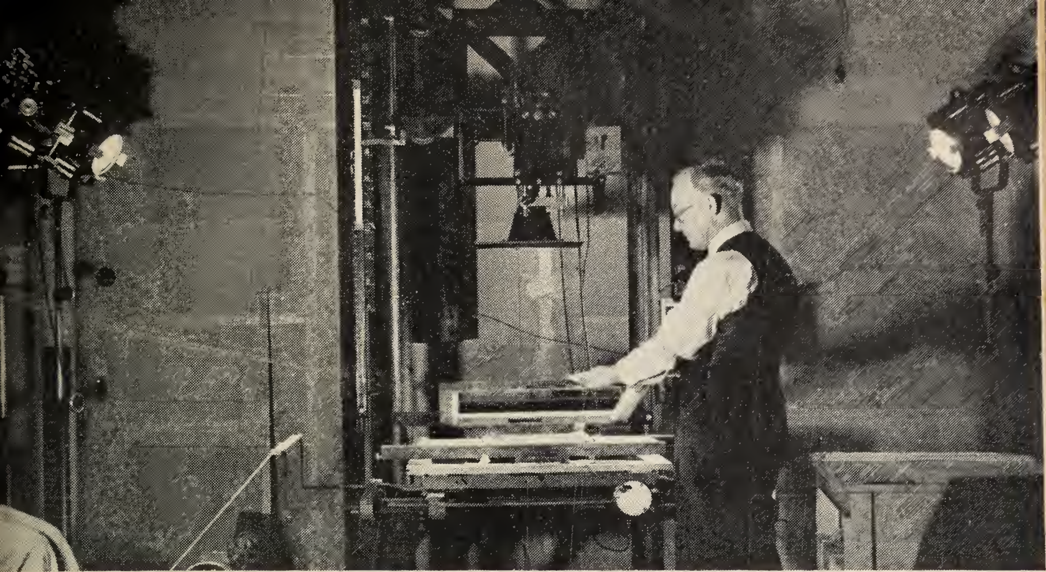


Fig. 10. The Animation Camera.

vocal track, two or three effects tracks, and often two music tracks—an average of five or six tracks, all of which must be properly balanced. The picture may be run twelve or fifteen times before the track is recorded, each time with a slightly different balance of the component tracks.

DISCUSSION

A VISITOR: Can Mr. Hand describe the Disney Multiplane camera?

THE AUTHOR: The Disney Multiplane camera is about 18 or 20ft. high; between the camera and the background plane are several planes, each capable of moving individually. Each plane consists of a plate-glass with registering pegs, and its own lighting system.

Mr. F. RODKER: How are special effects, such as water and rain produced?

THE AUTHOR: Water effects can be created in two ways: either by orthodox animation, or the character to be reflected can be photographed in a mirror through a distorting glass. Rain is usually produced by superimposing "live action" on the scene, although it may actually be animated.

Mr. WILLS: How is the effect produced of living persons moving among cartoon characters?

THE AUTHOR: There are two methods of combining cartoon characters with live actors. In one system, the cartoon may be made first, and the live actors added by projecting the cartoon as a back-projection shot while the actors are photographed in the foreground. A more complicated method is the double-printing process: the animator takes a rough tracing of the previously photographed live actor's action, and then animates his drawings to fit in with the live action: the finished films are then double-printed through appropriate mattes.

Fig. 11. Guide Score for Music.

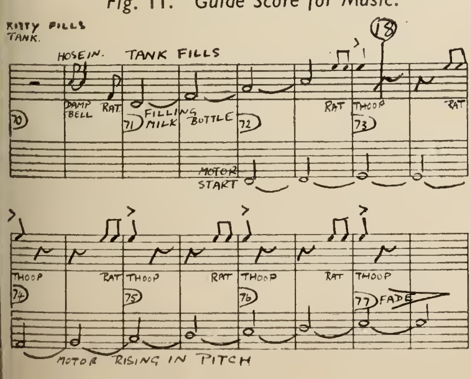
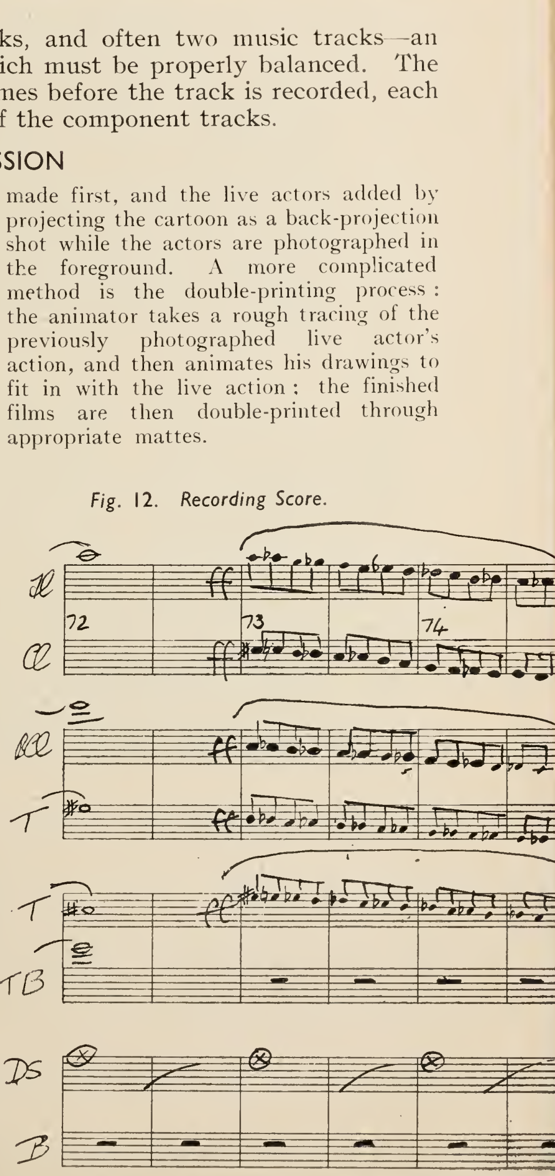


Fig. 12. Recording Score.



VISUAL METHODS OF EDUCATION

H. E. Dance, A.M.I.C.E., M.B.K.S.*

Summary of paper read at a joint meeting of the Royal Photographic Society with the British Kinematographic Society, on the 21st January, 1947. Reprints have been sent to members of the Sub-standard Film Division, and are available free of charge on request.

IN his introductory remarks, Mr. Dance classified his subject under three headings, first, direct observation ; second, personal communication, in relation to speech and teaching aids ; and third, remote communications such as printing, kinema, wireless, television, etc.

The first group fell outside the present discussion. Visual methods in the second group were used by the teacher to assist in the conveyance of ideas with greater precision and attraction. This was the group on which the present discussion was to be concentrated.

In the third group the material was designed for an average audience of such material. Only in the case of printed matter was reference at all easy ; footage numbering of film would facilitate reference.

Classroom aids could be specified under the following headings :

1. Specimens.
2. Models.
3. Books and print.
4. Episcope.
5. Display panels.
6. Charts and Diagrams.
7. Chalkboard.
8. Standard Slides.
9. Miniature Slides.
10. Film Strips.
11. Kinematograph film.
12. Special apparatus.
13. Visual units.

The standard lantern slide best served the purpose for the display of still photographs, but was costly, involving postage and packing, and circulation was limited. It was likely to be displaced to a certain extent by film strips. Children should be encouraged to look at a film or film strips in the same way in which they referred to the books in the school library.

Negatives of film strips could be reproduced at low cost and high speed. A set of 40 pictures could be delivered to a school at prices ranging between 7s. 6d. and 12s. 6d., and the material could be left in the school after use. Pictures, however, were costly and the original film strip containing 40 pictures might cost £200.

The mere fact that there were 40 pictures or so in a film strip would mean that the teacher might find himself showing a sequence which he did not want, but cutting and mounting as slides could solve the problem. The filing of film strips presented certain difficulties which would be regulated by the teacher.

The projector with a long throw was of little use to a teacher in the class room ; what was required was a projector of short throw, under one's hand. The picture should not be projected in full darkness nor on to a white screen, but under conditions in which one could work as a teacher. The teacher should be able to see the children and *vice versa*, but some control of lighting was essential both from an educational and photographic standpoint.

In the discussion which followed, Mr. Calvert pointed out that Mr. Dance had not mentioned in detail the individual costs for teachers who made their own material. Double frame film strip cost 4½d. per picture for the negative and 1½d. for the print, so that each picture cost 6d. A group of teachers sharing the cost per picture would reduce the price to 2d.

* Ministry of Education

DEMONSTRATIONS OF NEW EQUIPMENT

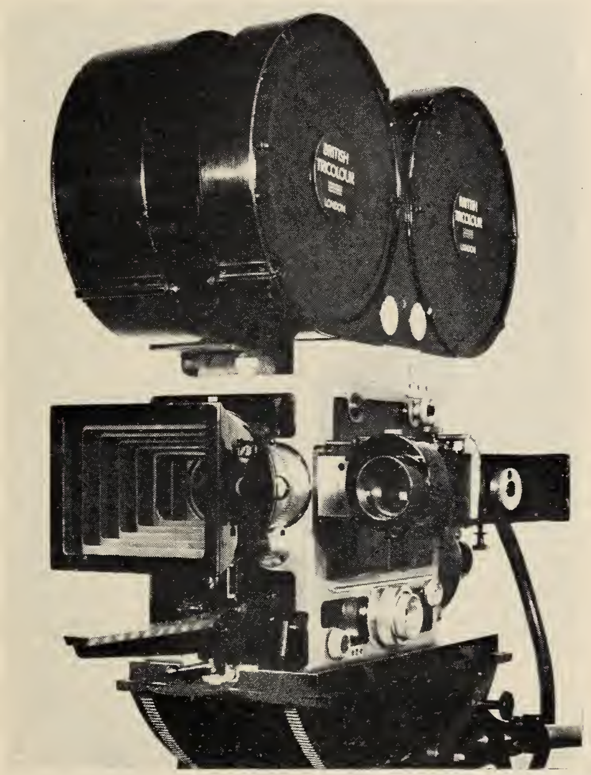
At the meeting of the Film Production Division, held on the 23rd April, 1947, a number of manufacturers demonstrated newly developed equipment.

THE BRITISH TRICOLOUR CAMERA

Jack H. Coote, M.B.K.S., F.R.P.S.*

THE British Tricolour camera is designed to produce standard 3-colour separation negatives for printing by the British Tricolour process, though other subtractive printing processes could be used satisfactorily.

The camera is of the " bipack and one " type, having two exposure planes at right angles, exposing a single film at one plane and a bipack at the other. A prism block, incorporating a partial reflecting surface at 45 degrees to the lens axis, provides the two light paths. The reflecting surface is metallised with gold to give the correct ratio of reflected to transmitted light for proper balance of exposure at the two film planes. The green record is exposed on a single film by transmitted light, the blue and red records are exposed by reflected light on the front and back films respectively of the bipack.



Two of the latest type Vinten movements are used in the camera. The bipack gate may be swung away from its operating position thus making loading easier and avoiding the use of a hinged lens panel.

The three rolls of film stock are housed in two separate magazines, instead of a single magazine containing all three. The use of two magazines allows the camera to be loaded without removal from its blimp. One magazine serves the single-film side of the camera which is loaded in the normal way, while the bipack is threaded through the camera from the opposite side, both films being housed in the second magazine.

The Mitchell viewfinder is coupled to the lens for automatic correction of focus and parallax. Selsyn type focusing, if required, operates both lens and viewfinder together.

A range of driving motors permits the camera to be used in conjunction with the usual sound system drives, including a " wild " motor, Western Electric 220 v. interlock, Western Electric 12 v. D.C. interlock, RCA and B.A. 220 v. ynchronous.

* British Tricolour Processes, Ltd.

The optical system was designed by Mr. C. G. Wynne, of Wray Ltd., and includes five special $f/2$ lenses of 25, 35, 50, 75, and 100 mms. focal length.

DISCUSSION

Mr. A. W. Watkins: Is the camera completely quiet, or have you designed a blimp for it? Would it not have been an added advantage to have had a selsyn drive for the focus rather than hand focusing?

The Author: The camera is reasonably quiet, by comparison with three-film cameras, thanks to the Vinten movements used. A blimp is in hand.

I would add that the camera was made almost single-handed in a very small workshop by Mr. Gilbert Murray.

VISATONE LIGHT PORTABLE SOUND RECORDER

D. Forrester, M.B.K.S.* and R. Firth*

ALTHOUGH its size and weight are extremely low, the performance of this equipment is comparable with that of much bulkier equipment.

A fluid fly-wheel and carefully matched mechanical filter provide a smooth transmission of the film past the recording beam and ensure a clean " wow-free " result. An illuminated footage counter, which is re-set by a knob at the left of the case, registers the amount of film which has been used. A marker light is provided to give a synchronisation mark.

The driving motor has been especially designed to operate either from a 12 volt accumulator or an 8 volt 3-phase A.C. circuit.

When operating from an accumulator the speed is governed to very fine limits and an alternating current is generated which can be used for interlocking with the picture camera. H.T. is produced by a vibrator very efficiently filtered.

The Optical Modulation Unit is very small in size; adjustments have been reduced to a minimum. Modulation can be observed through a microscope and a self-closing aperture in the door.

The Recorder weighs 50 lbs. and measures 12 in. × 10¼ in. × 10½ in.

DISCUSSION

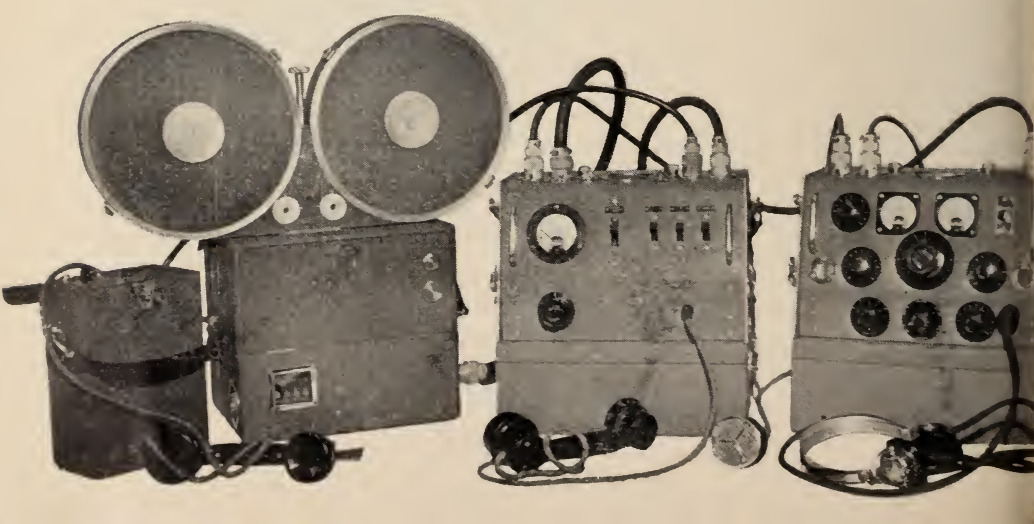
Mr. H. Wentzel: You did not mention the noise reduction system employed.

Mr. Forrester: Generally you are modulating at the order of 110%; in consequence any noise reduction system is merely adding to the size of the equipment. Most tracks are re-recorded for the purpose of the commentary, and noise reduction can be introduced at that stage.

Mr. Baber: How do you measure wow and flutter?

Mr. Firth: It is below any audible level. We have not measured it, because we have not found it worth measuring.

* Films and Equipments, Ltd.



FOUR-WAY SYNCHRONISER AND CUTTING TABLE

D. Forrester, M.B.K.S.*

A FEATURE of the new model synchroniser is that a viewing light is incorporated in the base ; the centre portions of the sprockets are of Perspex, through which the light reaches the film, and which gives the cutter a firm surface on which to mark his films. The principle has been found particularly useful for a 16 mm. synchroniser, on which there is only one row of teeth.

The cutting table, formerly made of steel, is now constructed of duralumin tube. Again, Perspex is used for the lighting system, which employs a fluorescent tube. Provision is made for linen bags for the film.

DISCUSSION

Mr. N. LEEVERS : Does the fluorescent lighting conform to regulations ?

THE AUTHOR : Yes, it is completely enclosed with a double thickness of glass, and meets Home Office regulations.

A VISITOR : Is Perspex also agreeable to the Home Office views ?

THE AUTHOR : So far we have not obtained any reaction on that point. Our own tests show that, while Perspex in swarf form is very inflammable, in its sheet form it is nothing like so inflammable as the material used on the top of it. It has been installed in four or five studios, and has so far met with approval.

Mr. A. W. WATKINS : Has the synchroniser a brake on each channel, or on the first one only ?

THE AUTHOR : On the master only.

Mr. A. W. WATKINS : Do you consider that better from the cutting point of view, or is it better to have each one separately controlled ?

THE AUTHOR : The point is rather a difficult one. It has become an accepted practice that the first sprocket is the guide track, therefore it would appear to be reasonable to brake the first track only. There would be no difficulty in making any one of the others brake.

We have just produced another synchroniser which gives a picture track on the first, plus six 17.5 mm. sound tracks.

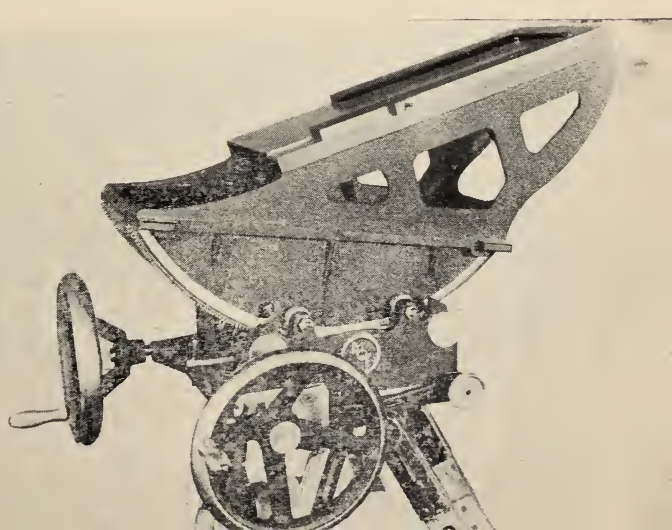
LIGHT MODEL ROLLING CAMERA HEAD

R. B. Paine, M.B.K.S.†

THE Moy Light Model Rolling Camera Head was originally designed to take the Technicolor " wild " camera for use on location and travelogue work. It has subsequently been adapted for the Tricolour camera and for black-and-white cameras.

The camera platform and quadrant is supported by rollers fixed to front and rear lateral shafts, ball-bearing mounted in the main base. The rollers also provide the lateral guide to the platform. Internal rollers fixed to the main base provide the steady guide for the platform. The rear lateral shaft carries two pinions, meshing with the geared quadrant and is fitted to a reduction worm box to form the tilt drive. The main base is fitted by means of a special ball race to a fixed worm wheel which is in turn mounted to the tripod or velocitator head. A worm mounted in the main base meshes with this worm wheel to provide the panning drive.

Balanced handwheels of large diameter are provided for both pan and



* Films and Equipments, Ltd.
† Ernest F. Moy, Ltd.

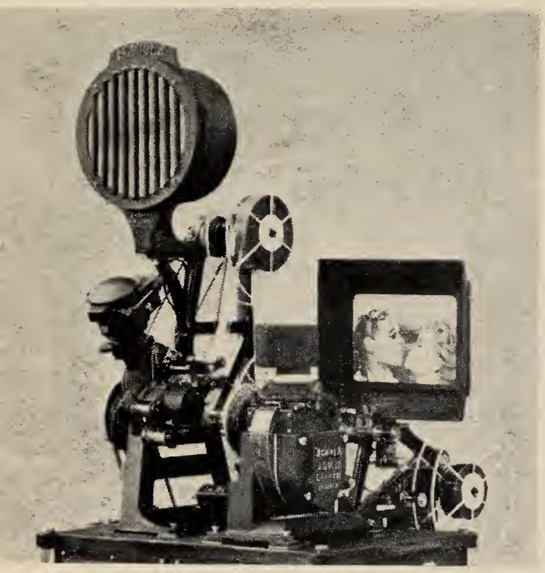
tilt. A 2-speed gear box giving 2.7–1 speed up or normal speed can be fitted to the tilt if desired. Both pan and tilt drive can be disengaged to allow free movement and a telescopic handle is provided. Brakes are fitted to both pan and tilt. Two spirit levels are fitted to the main base. The positive and negative tilt is 30°, but a camera wedge is provided in order to obtain an additional 25° both ways. A camera adapter plate is provided for fitting the camera.

The head is designed to carry 150 lbs. The weight of the head is 54 lbs., of the wedge $11\frac{1}{2}$ lbs., and the weight of the adapter plate is 10 lbs.

ACMIOLA EDITING MACHINE

D. T. Myers*

THREE different types of Acmiola are made : the first type provides an 8 in. projected picture, while the others are fitted with a viewing lens, one with and the other without take-off and take-up. The screen of the model shown can be removed, enabling a larger picture to be projected—up to 3 ft. in a darkened room. The lamp is 60 watts only, and there is no danger of fire ; the optical system comprises a spherical mirror.



The machine can be run forwards or backwards, at synchronous speed or at variable speed. The amplifier and sound equipment are the same in all three models.

DISCUSSION

Mr. A. W. Watkins : Is the viewer interchangeable with the type of local viewing ?

The Author : No, we have not got the ordinary viewing lens. But we have this advantage : as before, we can open the gate to mark the film. The mirror box system is very robust. Adjustment is provided for focussing for change of distance.

A Visitor : What means have you for keeping the picture in rack ?

The Author : We have a racking device at the side.

JOINING PRESS

D. T. Myers*

A FEATURE of the joining press is that it is adaptable to either 35 mm or 16 mm., by means of retractable pins. The machine may be supplied with either negative or positive guide pins ; in the case of the 16 mm. pins, allowance is made for longitudinal shrinkage, while in the case of 35 mm., allowance is made only for lateral shrinkage. A heater is incorporated ; this and the viewing lamp comply with all regulations.

The benches at the sides of the table can be adjusted to suit either vertical or horizontal winders. The machine is made throughout to the highest standards of precision, the cutting blades for instance being ground to within .0002 in.

DISCUSSION

Mr. W. Bland : Do you find much call for the combined machine ?

The Author : Yes, there is quite a lot of 16mm. work being done. We are also making a straight negative and a straight positive joiner, and we also make diagonal joiners which suit also 17.5mm. for sound.

* Acmade, Ltd.

TECHNICAL ABSTRACTS

Most of the periodicals abstracted may be seen in the Society's Library.

MOTION PICTURES ON OPERATION CROSS-ROADS.
R. J. Cunningham, *J. Soc. Mot. Pic. Eng.*, June, 1947, p. 554.
A brief description of the kinematograph equipment provided for the filming of the Bikini atom bomb tests indicates that a wide use was made of electronic control. R.H.C.

PROPOSALS FOR 16MM. AND 8MM. SPROCKET STANDARDS.
J. S. Chandler, D. F. Lyman, and L. R. Martin, *J. Soc. Mot. Pic. Eng.*, June, 1947, p. 483.
Proposed dimensions for 16mm. and 8mm. feed and hold-back sprocket, make allowance for specified maxima of shrinkage and provide that slippage of the film, when its pitch differs from that of the sprocket, shall be in the opposite direction to the direction of travel. Recommended radii of bending of the film on engagement with and disengagement from the sprocket are proposed. Reference is also made to the side guiding of the film.
R.H.C.

HISTORICAL DEVELOPMENT OF SOUND FILMS.
E. I. Sponable, *J. Soc. Mot. Pic. Eng.*, April, 1947, p. 275.
This paper deals with the early efforts and achievements of many pioneers in photographic recording, whose contributions form the basis of systems now in use.
Concise notes cover each stage of development and while these are primarily in chronological order, they fall naturally under seven sub-headings :

1. Early developments.
2. The work of Case and De Forest.
3. Commercialisation of Fox-Movietone.
4. Foreign Progress.
5. Western Electric.
6. RCA.
7. Miscellaneous Systems.

The author disclaims the intention of giving a truly balanced treatment of this wide field, but through his association with the work of T. W. Case is able to portray the development of the glow tube system in some detail, and by including the progress of commercial exploitation in relation to purely technical results he has given a vivid picture of pioneer sound development prior to 1930. N.L.

SOME SPECIAL PROBLEMS OF POST-SYNCHRONISATION MIXING.
T. Lawrence, *J. Soc. Mot. Pic. Eng.*, April, 1947, p. 317.
Post-synchronisation has developed from a rough-and-ready means of fitting dialogues to silent shots or faulty sound shots into a highly organised means of translating films into foreign languages. In recreating the original atmosphere of the film the mixer pays particular attention to acoustics in microphone setting up ; examples of this are quoted.
N.L.

LE NOUVEAU MICROPHONE CARDIOIDE LMT 3639 A.
E. R. Francois, *Tech. Cine.* No. 47, June, 1947, p. 1081.
Dealing first with the theoretical derivation of the ideal cardiod microphone from the combination of a pressure element with velocity element, the paper deals with practical examples of each in turn, showing how their individual performances depart from the ideal characteristic, particularly at the extremes of the audio spectrum.
It is shown that slight departures from the ideal polar diagram in the case of the pressure element may be compensated by equalisation of the velocity element, and that by careful juxtaposition phase errors may be minimised, giving good polar response and linearity over a wide range of frequencies. N.L.

THE CONCENTRATED ARC-LAMP AS A SOURCE OF MODULATED RADIATION.
W. D. Buckingham and C. R. Deibert, *J. Soc. Mot. Pic. Eng.*, April, 1947, p. 324.
In the concentrated arc-lamp, radiation occurs from the molten zirconium cathode and also from the glow region between the electrodes. The former radiation is visibly

stronger but cannot be satisfactorily modulated at high audio frequencies, while the latter provides a useful source of modulated light, particularly in the smaller sizes of lamp. Radiation from the two regions differs greatly in spectral distribution thus providing an effective means of controlling the modulation characteristic.

Spectral characteristics and performance data are given for several types of lamp and suitable modulating circuits described. N.L.

THE COUNCIL

Meeting of September 10th, 1947

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), P. H. Bastie (*Hon. Treasurer*), C. Cabirol, C. H. Champion, Rex Hartley, B. Honri, Leslie Knopp, A. W. Watkins, H. S. Hind (*Representing Sub-Standard Division*), G. E. Burgess (*Representing Film Production Division*) and R. H. Cricks (*Secretary*).

Film Production Division.—The President welcomed Mr. George Burgess, the newly elected representative of the Film Production Division.

Finance Committee. It was reported that the accounts and financial situation had been studied together with the best means of ensuring the future security of the Society The work of the Finance Committee is continuing.

Fellowship Committee.—The Council ratified the recommendations of the Committee to confer the Fellowship upon Mr. Rex Hartley and the Hon. Fellowship upon Messrs. P. H. Bastie and A. G. D. West.

Constitution.—It was reported that draft constitutions of the Divisions and Branches were in the hands of Mr. Barrs Davis (Solicitor), for consideration.

Papers Committee.—The lecture programme for the coming session was surveyed.

Membership Certificates.—It was reported that certificates of Fellowship, Membership and Associateship would be shortly ready. It was agreed that they should be distributed as the 1948 subscriptions were received, and that no charge should be made.

Proposed Equipment Division.—A memorandum from Mr. H. Bastie, Jnr., was considered suggesting the formation of an Equipment Division. It was decided that the formation of such a Division would not be advantageous to the Society at the present time.

Sub-Standard Film Division.—The following Committee was appointed to handle the Society's participation in the 1948 Physical Society's Exhibition : Messrs. W. H. Harcourt (*Chairman*), W. Buckstone, H. S. Hind, George Jones, H. C. Stringer and S. B. Swingler. Mr. Knopp agreed to give assistance where necessary.

EXECUTIVE COMMITTEE

Meeting of 5th September, 1947

Present : Messrs. I. D. Wratten (*President*), E. Oram (*Hon. Secretary*), Miss S. M. Barlow (*Assistant Secretary*).

Elections.—The following were elected :—

John Charles Milne (Member), Electric Construction Co.
Frank Alexander Beake (Associate), Ilford, Ltd.
Archibald Fleming (Member), Kelburn Cinema, Renfrewshire.
Jeffrey Mendelsohn (Student).
Richard Walter Lowden (Member), Royal Aircraft Establishment, Farnborough.
Edgar Brandt, B.Sc. (Associate), Scientific and Documentary Films.
Francis William King (Associate), Film Producers Guild.
Dennis Frederick Billings (Associate), Malvern Picture House.
Wm. Henry Pendleton (Associate), Assistant Cameraman Trainee.
Alec. John Appleby (Associate), Ilford, Ltd.
William Vincent De'Wan (Member), Gaumont British Pictures.
Arthur Thomas Bale (Member), British Thomson-Houston.
Vilnis Zuze (Associate), Kinematograph Engineer.
Sidney Leslie Carpenter (Member), Paduoc House, Wembley.
Pramathesh Chandra Barua, B.Sc. (Member), Film Director, India.
Robert Robertson, B.Sc. (Member), A. Kershaw & Sons, Ltd., Leeds.

Transfers.—The following were transferred from Students to Associateship :—

Gerald Denis Grimsdell, Mullard Wireless Services, W.1.
Albert Louis Burton, G.B. Screen Service, W.1.
Donald Garside Daggett, British Tricolour Processes, Ltd.

(*Continued on page* 130)

(*Continued from page* 128)

The following were transferred from Associateship to Membership :—
COLIN MARTIN WILLIAMSON, Williamson Manufacturing Co., Ltd., N.W.10.
CHARLES FER, Cinex, Ltd., W.C.2.
ROBERT McVITIE WESTON, S.I.M.P.L., Ltd., S.E.1.
JAMES ALEXANDER McDONALD, Mole Richardson (England), Ltd., N.W.10.
HANS WETZEL, G.B. Instructional Films, Ltd., Herts.
FRANCIS JULIAN WINTLE, Guild House, W.C.2.
JOHN A. S. TURNER, Pathé Pictures.
ROBERT GRAHAM BELL. G.B. Kalee, Ltd., Glasgow.

Reinstatement.—The following was reinstated in the Associateship :—
M. K. HANKINSON, Merlin Film Co., Ltd., W.C.1.

Resignation.—Owing to his having severed his connection with the film industry, the following resignation was accepted with regret :—
G. ALMOND.

STANDARDISATION OF PICTURE AND SOUND NEGATIVE REPORTS

The desirability of standardising picture and sound negative reports has for long been recognised, and a year ago a Committee was appointed by the Film Production Division to consider the matter.

A committee of the British Film Producers' Association has been able to devise and recommend standard forms for both picture and sound negative reports on the lines laid down by the above-mentioned committee. Before doing so, it consulted the Film Laboratory Association and examined many of the different styles now in use. It has attempted to embody the best points of each in its final design.

These standard forms were put into use simultaneously at all B.F.P.A. member-studios as from the 1st September.

The forms as finally designed have no revolutionary features. Takes are enumerated vertically with a bold "P" against those it is desired to print. The footage reading at the end of each take and the footage used are noted in special columns, these two figures being self-checking. It is recommended that a separate sheet be used for each complete magazine, although this may not be necessary when small lengths of negative are being used up, or on such occasions as music recorded sessions.

A small stock summary is provided at the foot for the use of any studios that do not employ separate forms for stock record purposes. The forms are in quintuplicate, the sheets being distributed to the labora tory, cutting rooms, production offices, accounts department or stores, and camera department.

Specimen sets of forms can be obtained on application to the B.F.P.A., 17, Waterloo Place, S.W.1.

THE GERMAN FILM INSTITUTE

The German Film Institute, situated in Hamburg (states *Sight and Sound*) now provides offices for the Broadcasts and Teaching Aids Sub-Section of the Education Branch of the British Control Commission for Germany, which has undertaken the task of reorganisation for the production and distribution of teaching aids.

A special organisation composed of education authorities of the Lander in the British Zone has been inaugurated to undertake the work of purchase and printing of films and the distribution of apparatus

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of the Journal.

KEN CAMERON, of the Crown Film Unit, has been seconded to the Canadian Film Board, and will be in Quebec for a few months.

F. MIDGLEY, formerly of Midgley & Harmer, is also in Canada, having established the Steelmaster Company, 950 S.W. Marine Drive, Vancouver, for the production of mechanical and electrical equipment; he offers his assistance to any members who may visit Canada.

STANLEY SCHOFIELD has started business on his own account in 16 mm. production and consultative work, specialising in medical subjects.

T. G. STANFORD, who has been engaged in the production of Service films, hopes to be demobilised in November.

ERIC WILLIAMS, probably one of the most travelled people in the film industry, is again in this country; he reports an increased interest in Australia in British films and equipment.

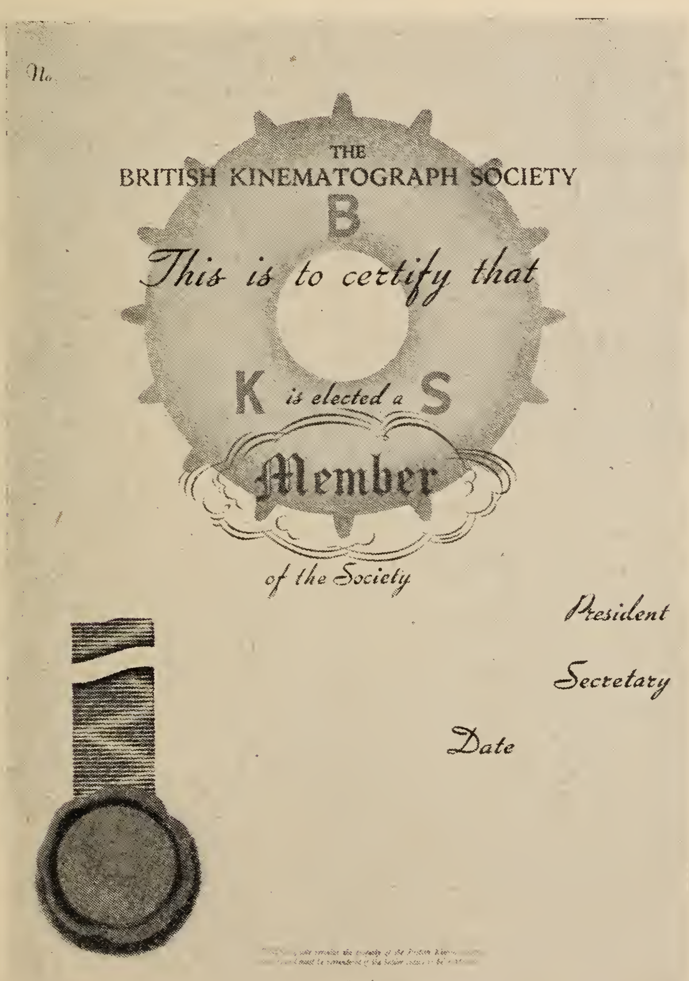
E. P. WILLIAMS, of G.B., is recovering from a protracted illness due to pneumonia.

BRITISH KINEMATOGRAPHY

The Journal of the British Kinematograph Society

VOLUME ELEVEN, No. 5. NOVEMBER, 1947

MEMBERSHIP CERTIFICATES



Certificates of Fellowship, Membership and Associateship will be available shortly for distribution. Those for the Fellowship are in red, for the Membership in dark blue, and for the Associateship in light blue.

In order to facilitate office work, preparation of the Certificates will be put in hand on receipt of the 1948 subscriptions.

THE ANSCO COLOR PROCESS

E. A. Williford*

Read to the British Kinematograph Society on April 9, 1947

ANSCO COLOR is an integral subtractive colour process using the method of dye coupling for the production of dye images in a multilayer material. Colourless colour-forming components are incorporated in the emulsion layers. The important property of the colour formers in the Ansco Color process is that they are of a molecular structure which renders them non-diffusing. Hence, they remain immobilised in their respective emulsion layers and do not bleed into adjoining layers.

Fig. 1 shows the layer arrangement of Ansco Color Film. The film base, which can be either cellulose nitrate or acetate, carries a colloidal silver anti-halation layer followed by the red-sensitive emulsion layer. This emulsion

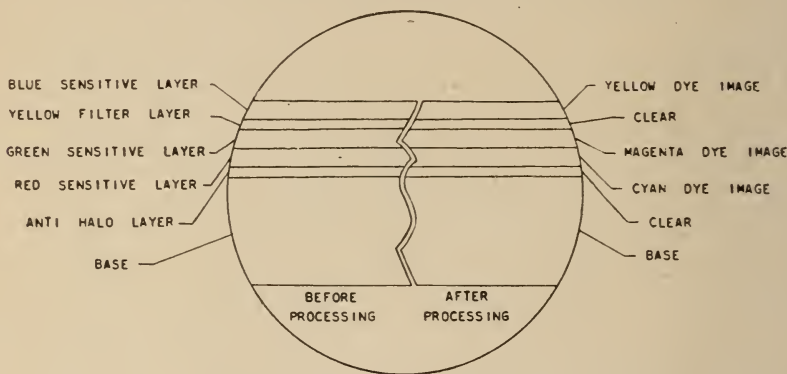


Fig. 1. Section of Ansco Color Film.

layer also contains a colourless dye-forming component which, upon development in a suitable colour developer, develops an image in colour complementary to the colour sensitivity of the layer. In the case of the red-sensitive emulsion layer, the colour is blue-green or cyan. For reasons of simplicity, this layer is usually referred to as the " cyan " layer.

The green-sensitive middle layer contains a colour former which, upon development, produces a magenta image, therefore called " magenta " layer. A yellow filter layer, coated on top of the magenta layer, absorbs all blue light, which would normally affect also the cyan and magenta layers and, therefore, has to be filtered out in order to obtain the desired separation of colour in these layers. The top emulsion layer is blue-sensitive only, and the non-diffusing colour former in this layer develops to a yellow image. This layer will be referred to as the " yellow " layer.

The colour formers in all three layers have been carefully selected so that they develop to a cyan, magenta and yellow colour respectively, in one colour developing step. This greatly simplifies the processing of the film and makes it possible to have the complete processing and finishing done by the consumer.

Thus far, this general description of Ansco Color also applies to Agfacolor.[1] In other words, both processes are based on the same fundamental patents, which cover methods for preventing the diffusion of the colour formers or components. The further research and development which is always necessary to bring patents to fruition in the form of marketable products was carried on

* Vice-president, General Aniline & Film Corporation

by Ansco independently after the separation from Agfa before the war. Therefore, Ansco Color films and processing methods are considerably different from those marketed as Agfacolor. Part of this is due to the difference in the consumer demand of the American market as opposed to the European, and part to the different approach of the American research and development scientists.

The fundamental principles of both processes are applicable to a great variety of colour products, such as Ansco Color Printon and Ansco Color Paper. Ansco Color Film of the reversible types for exposure by daylight and tungsten light has been in use for some time in the form of 16 mm., 35 mm. cartridges, roll and sheet film. These latter materials are being manufactured for use primarily for direct projection or viewing, and, therefore, have gradation characteristics which make them particularly well suited for this purpose.

Requirements of Film Industry

These same films, however, have not been found suitable for the motion picture industry, where the requirements are essentially different. The most important requirement for an original colour transparency suitable for 35 mm. motion pictures is that it lends itself to the printing of first and second generation duplicates with a minimum loss in colour brilliance and fidelity.

The demands of the professional motion picture industry on the photographic manufacturer are the most exacting of any in photography where any appreciable quantity of materials is involved. A variety of films is necessary to meet the various studio and laboratory specifications. The manufacturer of photographic films is directly concerned with the following important phases of making a feature picture :

(1) Photography of the original scene.
(2) Process photography involving intermediate duplicates or masters for including the special effects, such as photomontages, lap dissolves, fades, wipes and background projection ; also, provision for protecting the original film which represents the only tangible assets of the producers' investment is made during this phase.
(3) Printing of the releases.
(4) Processing ; and
(5) Sound Reproduction.

I. PHOTOGRAPHY

The film which has been designed for the photography of the original scene is a soft-gradation reversible film which is designated as Ansco Color Type 735. The primary consideration leading to the selection of a reversible film instead of a negative, as is used in the Agfacolor process, was the advantage of finer grain which an original reversible film offers. This becomes apparent only when it is necessary to make intermediate duplicates, a practice which was not used to any extent in the production of Agfacolor feature pictures, but one which is most important to the American market where approximately forty per cent. of the average feature consists of special effects and where release in other countries is planned.

Fundamentally, Ansco Color Type 735 is quite similar to the other Ansco Color Films and the layer arrangement is the same as shown in Fig. 1. It differs from the regular sheet, 16 mm. and roll films primarily in that the gradation of Type 735 is considerably softer and the colour balance is purposely slightly off-neutral.

Fig. 2 shows a comparison of the H and D curves of Ansco Color Type 735 and the regular Ansco Color Daylight Film Type 235. This new material is designed to provide a film for exposure in the camera which is ideally suited for

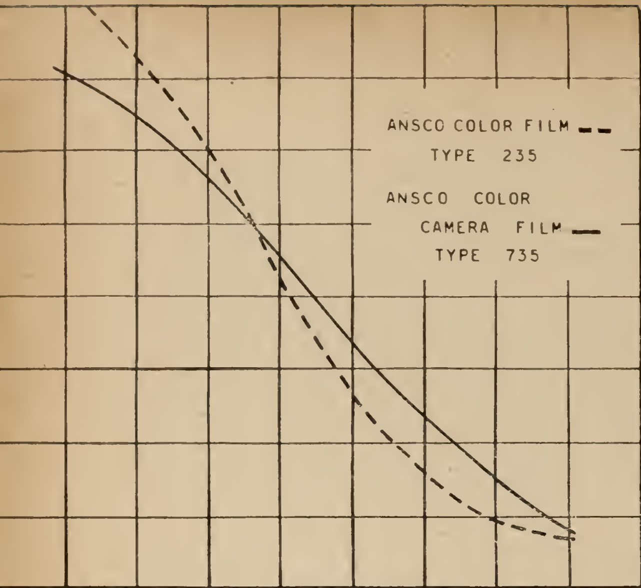


Fig. 2. Characteristics of Soft Gradation Type 735 and Daylight Type 235 Films.

printing, but is not intended for direct projection. In other words, its use should parallel the use of the original negative in black-and-white motion pictures.

For optimum print results, it is desirable that the original be slightly under-exposed or somewhat heavier in density than is the usual practice when exposing a transparency for screen projection. The reason for preferring a heavy original is to maintain as much of the exposure as possible on the straight line portion of the H and D curve and avoid inaccurate colour reproduction which results when the exposure falls predominantly in the toe region.

The film has an Exposure Index Number of 8 and is used with the same general type of studio and exterior lighting as is in current use with other processes for photographing colour motion pictures.

II. OPTICALS OR INTERMEDIATE DUPLICATES

The next stage in the making of a motion picture after a satisfactory original has been obtained and properly cut and edited is the preparation of intermediate duplicates by optical printing, during which stage the special effects are included. It is generally known that in colour reproduction each printing step results in a noticeable degradation in quality of colour reproduction due to the inherent characteristics of the image dyes. For this reason, it is desirable to reduce the number of printing operations in colour photography to a minimum. Where possible, it is desirable to print directly from the original, and this was practised in the Agfacolor process by including as many special effects as possible either directly in the camera or during the release printing operation. Typical of the latter are the pseudo-wipes which were obtained in Agfacolor prints by having a bar in the printer, which, actuated by notches, passed across the film, beginning a few feet before and ending a few feet after a splice, giving the illusion of an optical wipe. Chemical treatment of the original was also used to produce fades.

In order to provide protection against loss of the original, the Agfacolor method required three good takes of each scene. The number of takes made in Hollywood to obtain one which is acceptable to the director will indicate what additional expense the requirement of three satisfactory takes would involve.

Such methods are equally applicable to Ansco Color, but are not satisfactory for the American market, and three methods of making true opticals have been worked out. This requirement was the main consideration in the selection of a reversible film for camera use.

Duplication by Optical Printing

The first method consists of straightforward optical printing of the Ansco Color original on to Ansco Color Type 132 Duplicating Film. This duplicating stock is also a reversible film of soft gradation, but of slower speed and finer

grain, and requires approximately two to four times the light needed for black-and-white positive fine-grain stock. A duplicate is obtained which is substantially equal in contrast to the camera original. This first generation duplicate can then be interspliced with the original where the special effects are to be included.

There will be some loss of colour brilliance in the scenes prepared by this method. However, the loss is probably not serious enough to preclude its use for lap dissolves, fades and other special effects, especially if the subject of these special effects is of such a nature that a very critical judgment of colour rendition is not possible, and if the numbers of such effects are held to a minimum. However, this method is not recommended for full length intermediate duplicates because of the loss in quality of colour reproduction which will result.

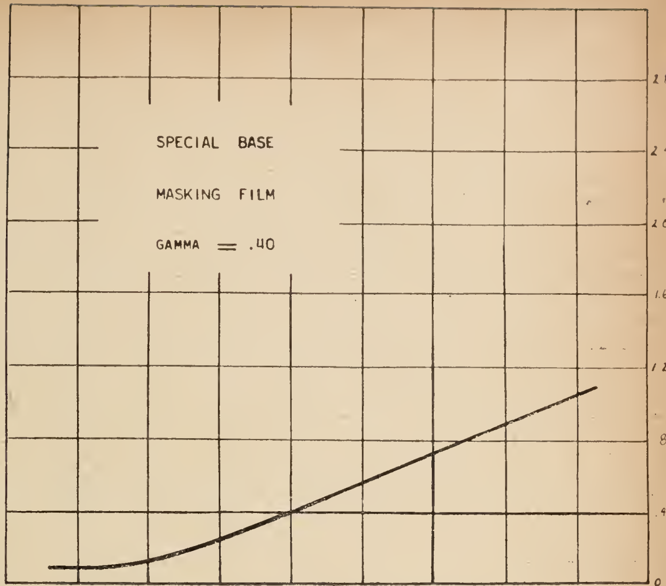


Fig. 3. Characteristics of Masking Film.

Masking Correction

The second method, and the one which is most likely to find general acceptance, is the use of a black-and-white mask in register with the original for colour correction when printing the intermediate duplicate. This method utilises the same duplicating film Type 132 as described for the first method, except it is developed slightly longer in each developer for higher contrast.

A special low-shrink, panchromatic, black-and-white film has been developed for masking in connection with the Ansco Color process. The characteristics of this material are such that the required masking densities are obtained with the least amount of critical control. For this reason, the gamma infinity of the material is adjusted to the masking requirements (Fig. 3). In order to ensure good registration of the mask, precision optical equipment is necessary as well as control of humidity and other conditions which affect the shrinkage characteristics of the masking film. With proper control of these factors good registration is obtained.

Exposure of the mask is made with a yellow filter if normal colour correction is desired. However, a great deal of control is available in the choice of the filter for this exposure, depending on the type of scene being printed; for example: if a scene

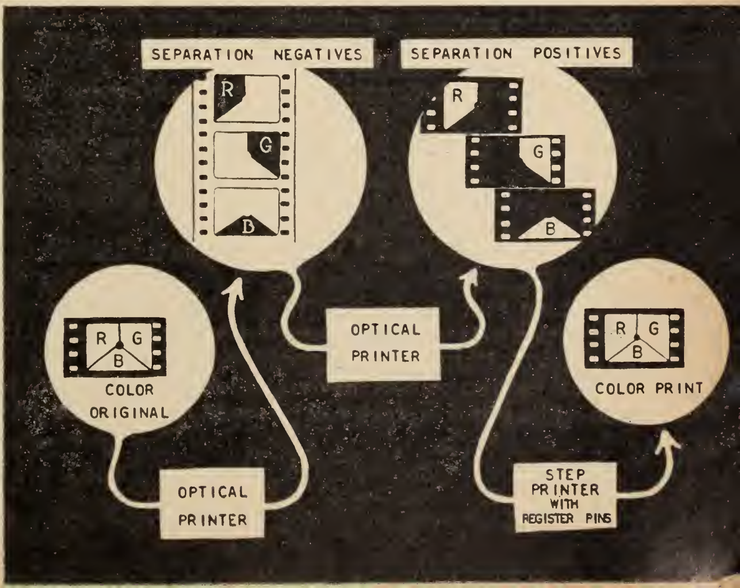


Fig. 4. Production of Release Prints by the Colour Separation Method.

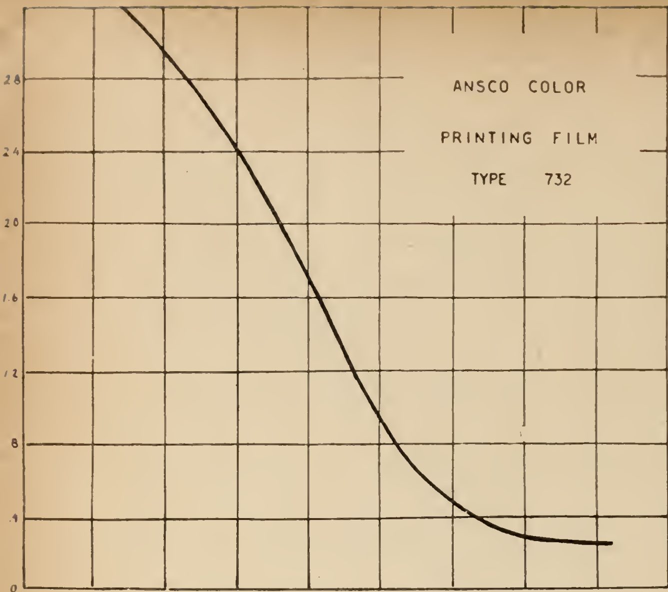


Fig. 5. Characteristics of Prnting Film, Type 732.

is predominantly green a more desirable effect may be obtained by making the mask with a magenta filter. Flexibility and control of the colour obtained is possible by this means. The black-and-white mask is then run in contact with the original, and the masked intermediate duplicate containing at the same time all of the effects, is printed. There is then obtained a conformed master which when printed will show little or no loss in colour brilliance. This masked master will also be balanced from scene to scene in regard to printing light and filter, and can be contact printed with standard continuous or step printers without the necessity for light changes or special provision for filter changes between scenes. Any number of such masters can be made for export release printing.

Since the original is not essential for release printing it can be stored in a safe place to provide insurance against loss.

Colour Separation Method

A third method for producing intermediate duplicates in the Ansco Color process was described in a paper by Harsh and Friedman[2]. This method utilises for separation negatives a black-and-white film which has the unique property of giving equal gradation for exposures by blue, green and red light. The purpose here is to expose as consecutive frames on the same strip of film, the red, green and blue separations, so that the problem of registration is minimised even though the film shrinks with age.

The steps of this procedure are shown in Fig. 4. This method has the disadvantage that a special skip-frame release printer is required or, if separate separation positives are made, the release printing will be somewhat slow. It has the advantage, however, that good permanent records of the colour original are obtained, and there is no need for masking to retain good colour reproduction in making the intermediate duplicates. It is an optional method for those who would prefer the additional investment in equipment in order to obtain the advantages offered.

III. RELEASE PRINTING

The release printing stock for the Ansco Color process is Ansco Color Printing Film, Type 732. This film is also of the reversible type, and while fundamentally similar to the other Ansco Color reversible films, it is characterised by a relatively low speed, very fine grain and special sensitisation for printing. This printing stock can be developed to a high maximum density to obtain optimum colour brilliance.

Fig. 5 shows a typical H and D curve for this film. A wedge spectogram of Ansco Color Printing Film (Fig. 6) shows relatively sharp sensitivity peaks in the green and red regions with a partial gap between these peaks. Good separation of the peaks of sensitivity is very essential in a printing film in order to obtain faithful colour reproduction.

Most motion picture printers which are suitable for printing fine grain black-and-white positive stock can be readily adapted to print Ansco Color Type 723

stock. If not already available, the following features should be provided on a printer to make it suitable :

(1) A light source which operates at a colour temperature of approximately 3,000° K. (2) A means for inserting printer filters into the light path quickly and conveniently. (3) A condenser lens system for the light source in order to concentrate the light at the aperture. (Ansco Color Printing Film, with the printing filters in place, will require two to four times the light needed for printing black-and-white positive fine grain stock.) (4) It is a good practice to provide an air blast or fan as a means of dissipating the heat from the lamphouse, in order to avoid damage to the filters and film.

Using a regular black-and-white printer with the modifications just described, the printing of the Ansco Color original on to Ansco Color Printing Film requires the insertion of filters to balance the colour quality of the light source. A standard series of Ansco Color compensating filters, in varying densities of yellow, magenta and cyan, are available for this purpose. Considerable control of the colour balance of the release print is possible by the selection of these printing filters.

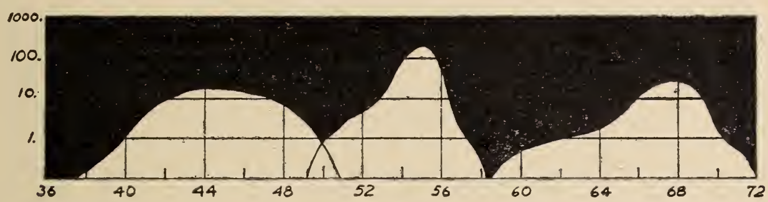


Fig. 6. Wedge Spectogram of Printing Film, Type 732.

IV. PROCESSING

The machine processing of Ansco Color has been previously described.[3] It is a straightforward reversal process requiring approximately 85 minutes, and all of the Ansco Color motion picture films which I have described can be processed in the same solutions, with only a slight variation in the developing times as shown in the table.

Developing Times of Ansco Color Films

	First Developer	Colour Developer
Type 735 Camera Film	9 minutes	11 minutes
Type 132 Duplicating Film (without mask)	8 minutes	9 minutes
Type 132 Duplicating Film (with mask) ...	10 minutes	18 minutes
Type 732 Printing Film	10 minutes	18 minutes

The processing of Agfacolor negative-positive Films, of course, avoids the first developing step. However, the times are not necessarily much shorter due to the special processing required for the sound track on positive film. The processing time for Agfacolor negative, as published, was 56 minutes, and for Agfacolor positive approximately 75 minutes.

The Ansco Color processing procedure has the advantage of including a hardening step, thereby eliminating much of the danger of reticulation which existed with the Agfacolor processing procedure. Agfacolor had the advantage that with only one developer the control of solutions was somewhat easier.

V. SOUND REPRODUCTION

Since the release printing stock for Ansco Color is a reversible film, a positive black-and-white track is required for printing. The ideal way to obtain the black-and-white positive would be a direct positive recording. However, equipment to record to a direct positive is not generally available, and the following method has been found almost equally satisfactory and is the one recommended.

The recording head of the sound equipment is moved so that the negative recording is obtained on the opposite side of the film. This negative is then printed on to black-and-white positive stock, which will then have the sound track in the proper position for printing directly on to Ansco Color Type 732 Printing Film in the conventional manner.

Blue-sensitive Photo-cell

Dye tracks, especially those obtained by the dye coupling method, have a relatively low absorption in the infra-red region. Therefore, the conventional infra-red-sensitive photo-cell, in theatre reproducing equipment, for example, the RCA Type 868, is not too well suited for these dye tracks, and a loss in volume amounting to approximately 6 db is encountered. This loss in volume, while serious, still comes within the range where adjustment can be made by fader setting on most 35 mm. projection equipment.

Fortunately, within the last few years the development of blue-sensitive photo-cells has progressed, and cells are available to-day which are ideally suited for dye tracks and will play normal silver tracks with approximately the same volume, so that interchange of cells is not required. These photo-cells are available from the Radio Corporation of America, designated as the 1P-37, and from Continental as the CE-91.

No special treatment method in processing to make Ansco Color prints suitable for the red sensitive photo-cells is now recommended, since it is believed that the eventual use of the blue-sensitive photo-cell is the ideal solution to the problem of dye tracks. However, if it proves impracticable to introduce the blue-sensitive cells into the theatres along with the release of Ansco Color feature pictures, methods of preferentially treating the track area will be made available. Such methods usually slow up the speed of processing of the printing stock and are not desirable if they can be avoided.

The Agfacolor method, using a positive film for release printing, has the advantage that the normally used black-and-white negative sound recording can be used. The multiple variable area track was commonly used in Germany by Klangfilm. The Agfacolor track of dye plus silver was obtained during processing by applying a viscous bleach in the picture area only. This operation slows up the processing procedure to such an extent that most of the processing machines in Germany ran at a very slow speed such as fifteen feet per minute.

Possibilities of Negative-Positive Method

In describing the reversible films which Ansco has now marketed for motion picture use, I do not infer that the negative-positive method has been definitely abandoned. In the present state of the art the Ansco films are more adaptable to meet the specifications of the industry, particularly in regard to providing

satisfactory intermediate duplicates, than the Agfacolor negative-positive method as it was used in Germany. In the future, it appears probable that a combination of reversible and negative and positive films will be utilised to give the combined advantages of both methods.

In any case, the motion picture industry can look forward to integral tri-pack colour films which they can process and print in their own laboratories with a minimum of special equipment, and which utilise techniques that can be readily mastered by personnel already skilled in the production of black-and-white motion pictures. I believe we can all look forward to continued advances in colour photography, and the day when all motion pictures will be in colour is no longer in the far distant future.

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2. *S.M.P.E. paper.* (Not yet published.)
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4. *J. Soc. Mot. Pic. Eng.* May, 1946, p. 387.

DISCUSSION

Mr. F. G. Gunn : Did I understand you to say that for making release prints, you could use either a coloured master copy or a black-and-white successive-frame copy?

The Author : Yes; you could use either.

Mr. Gunn : Which is the preferred method?

The Author : We feel that the multi-layer film used throughout is perhaps the preferred method. The separation process takes quite a lot of film, and special equipment. The use of a dupe negative which can be printed on a high-speed continuous printer, where the corrections are made in the dupe negative, is much more desirable.

Mr. F. Rodker : How does the cost compare with other colour systems?

The Author : I would not like to make comparisons. In the United States we are selling camera film on nitrate base for 12 cents a foot; we are selling duplicating film on nitrate base at 6 cents a foot, and the printing film at 5½ cents. The processing costs will vary, but there are firms who are handling the processing at about 2 or 2½ cents a foot.

Mr. I. D. Wratten : I should have thought that the costs of lighting, in view of the Weston reading of 8, and the colour temperature requirements, would be quite high.

The Author : We hope to have a Weston reading of 12 to 20. Our latest amateur film has a reading of 10.

Mr. F. Bush : When is the stock likely to be available for the production of feature pictures?

The Author : That depends upon how soon we can build the plant. Ansco Color Film goes through the coating machine five times, so the same machine that will give a million feet of black-and-white film will only give 200,000 feet of colour film.

Mr. Gunn : I take it the professional camera film is made for two colour temperatures?

The Author : Our daylight stock is made to work at 5,200° K. It is the desire of every producer to eliminate arc lamps and use incandescents. The amount of heat for the ergs of light energy on the set make it desirable to use carbon lighting unless there is some other form of light of that colour temperature which will give less heat.

Mr. Cherman : Is reduction printing from 35 mm. for 16 mm. release feasible?

The Author : Yes; it is very simple.

Mr. B. C. Sewell : Is the signal-to-noise ratio as high with the dye track as with a silver track?

The Author : It is apparently equal with the IP-37 tube.

Mr. Gunn : Would rushes be in colour or black-and-white? Is it expensive or inexpedient to give coloured rush prints?

The Author : I think colour is desirable. Alternatively, we can make coloured prints in 24 hours from the time the film is delivered to us. The expense is not very high.

Mr. B. C. Sewell : Is the camera film lower in contrast?

The Author : Yes, much lower in contrast; and it has a bluish tinge.

Mr. Gunn : The cutter has to start assembling and editing; he needs something more than the camera film.

The Author : As a practical method we would make rush prints on reversible stock.

Mr. J. Coote : Could Mr. Williford tell us whether he controls processing sensitometrically or chemically?

The Author : It is controlled by chemical analysis, as well as sensitometrically.

THE PLASTER SHOP

J. H. Grogan*

Read to the B.K.S. Film Production Division on Feb. 26, 1947

HISTORY proves that plastering is one of the oldest crafts, and the skill of the plasterer has played an important part in bringing about the measure of comfort and beauty we enjoy today. There is hardly a building of historical value anywhere in the world for which we do not owe something to the plasterer, who played an important part in bringing to fruition the original plans and designs.

It is recorded that the first time plaster casts were used to make more realistic stage settings, was for the production of "Romeo and Juliet" in 1860 at the Lyceum Theatre. Frequently since then, plaster has been used in the theatre for making stage props and moulds for reproducing papier mâché casts, but it was not until the advent of the film industry that plastering really came into its own as a medium for securing the desired effect in sets.

Application of Plaster

The reason for its wide use is due to the fact, that any conceivable effect, stone, brick, tile, rock or weathered timber, can be perfectly reproduced. Columns, cornices, dadoes, architraves, skirtings, panelling, ornamental picture frames, statues, in fact anything from the splendour of the baronial hall down to a table ornament, a mountain to a coal mine, a thatched farm cottage to the eggs in the hen-run, can be reproduced to perfection in the plaster shop.

If a director wants a vase that will break at the slightest touch yet looks perfectly solid, the plasterer makes it. If a building has to collapse, the plasterer makes the bricks, using a mixture of cork and plaster which is light, and remains solidly in position until it is required to collapse.

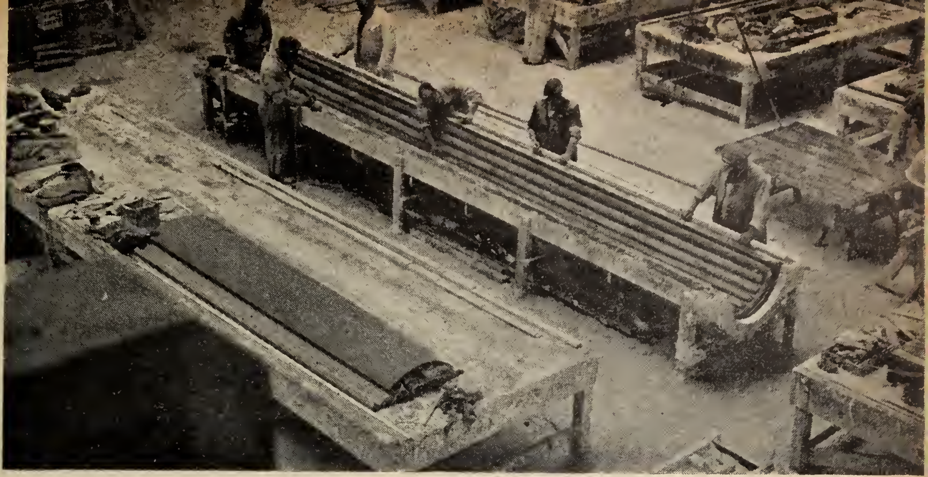
Plaster casts can be made strong enough to walk, run, jump on, or when required, to break at the lightest touch. The uses to which plaster can be put in a film studio are limitless. For miniature sets, the plasterer is once again called on to reproduce in miniature the bleakness of mountainous country with its gushing waters, moving glaciers, the trees and woods in the

Fig. 1. A Mould for casting Brickwork.

Fig. 2. A Section of Brickwork.

* D. & P. Studios, Ltd.

Fig. 3. A Mould for a Fluted Column



lower reaches, barns, houses and villages that dot the landscape, and even the people. To secure the trick effects in miniature needed to make a film realistic, plaster is used to great effect.

Plaster in Process Shots

A favourite trick process is the hanging miniature. The miniature, if it is a ceiling piece, is made up to scale and in perspective, is moulded, using one of the methods I will describe later, reproduced in one piece and hung in front of the camera, so that the camera matches it up perfectly with the full-size set.

Miniatures are often used to create the effect of distance, the miniature being placed near the camera and sighted so that it joins up perfectly with the action taking place in the background. A good example of this type of shot can be seen in "Caesar and Cleopatra," when the soldiers and people are gathered in the court-yard at the end of a magnificent colonnade. The colonnade was, of course, in miniature.

Moulding a Brick Wall

How are all these various effects and reproductions achieved? Before describing the more complicated reproductions, the production of those solid looking streets of brick built houses, etc., should be described.

First, a plaster model is made, on which the joints of the brick work are marked out; when the plaster is properly set the bricks are rubbed up with a wire brush to secure the desired degree of weather effect. The model is painted with three coats of shellac, dusted with french chalk to harden the surface, and then greased with a mixture of tallow and paraffin or linseed oil. The model is then ready for moulding.

Canvas and timber are prepared for reinforcing the mould. The "firstings" is brushed over the face of the mould and then splashed on to give the required $\frac{1}{4}$ in. thickness, after which the first layer of canvas is stretched over the "firstings" and brushed in with "seconds." Canvas and timber are then pasted with plaster, placed into position and lightly splashed to give added thickness and strength. When properly set the mould is given three coats of shellac, french chalked, greased and it is ready to cast the bricks for the set (Fig. 1).

The bricks are termed "skin casts"—that is to say, they are not reinforced with timber. When the cast is taken off the mould, it should be approximately $\frac{1}{4}$ in. to $\frac{3}{8}$ in. thick (Fig. 2). These casts are then taken to the set and nailed to a batten frame, the joints stopped with plaster so that the whole area is one continual surface of brickwork, which when painted cannot be distinguished from the real thing.

Stonework, rocks, cliffs, mountains are all done in the same way, the only difference being, of course, the shape and texture of the original model.

Fig. 4. *A Group of finished Columns.*

Fig. 5. *Moulding a Fluted Column. Canvas and Ba are being plastered in position.*

When there is action on them, they are not cast but modelled on a solid wood frame on the set.

Paving stones, cobbles and kerbstones are all made in the same way, except for the fact, that the casts are made thicker to stand up to the wear.

Fluted Columns

The fluted column is the most difficult of plaster shop jobs. The principle of turning an ordinary column mould is used in turning the bed into which the flutes are fitted. The columns shown in Fig. 4 were made at Denham for the film " Fame is the Spur," and were 3 ft. 6 in. in diameter and 22 ft. long.

First, zinc template is cut to the vertical profile of the column, but between the base and the necking, the template is so cut that it will form a bed for the flutes, which are approximately 2 in. to $2\frac{1}{2}$ in. thick. The template is nailed to a board, which is to be mounted on pivots in line with the centre of the column, so that when the template is turned it will run plaster to the required radius for the bed.

The next step is to make a heavy frame, with ribs and laths to form the approximate shape of the bed. To the end timbers are fixed the pivots on which the template turns. Plaster is gauged, and by means of the template the bed is cast to the form of the outer diameter of the column. The flutes are moulded in plaster ; to each flute is added a ground corresponding in depth to the extra radius allowed on the template.

The flutes are fitted in pairs in the bed, channels being cut in the bed for ropes to tie the flutes to the cast column. The mould is greased, and is then ready for casting (Fig. 3).

Canvas and battens are prepared to reinforce the cast. Plaster is gauged, the " firstings " is pasted over the mould and then splashed on to give the required $\frac{1}{4}$ in. thickness. Then the first layer of canvas is applied ; battens used to reinforce the edges are placed in position. The second layer of canvas is next placed in position (Fig. 5) and also brushed in with plaster and when this is complete the other four battens are placed in position, pasted with plaster and covered with canvas. Strips of canvas cut to fit round the column are next soaked in plaster and placed rope fashion round the cast.

When the cast is set, the ends of the rope which run under the flutes are tied across the top of the cast, and the whole taken out of the bed. When the cast is right out and turned so that it is safe to untie the ropes without fear of the flutes falling off, the ropes are untied and the flutes replaced into the bed.

Fig. 6. *A Clay Model for Gelatine Moulding.*

Fig. 7. *Gelatine Mould and a Cast.*

Gelatine Mould Making

The gelatine mould is used where enriched cornices, panels, plaques, are undercut to an extent where a plaster mould would break off at the edges.

The model (Fig. 6) is made in clay, smoothed over with paraffin or turpentine. A case is cast over the clay, heavily reinforced to stand the pressure of the gelatine when being poured. Funnels are fixed for pouring in the gelatine and small air holes are made to allow the air to escape when the gelatine is poured in. The case is then given three coats of shellac and greased.

The model is also greased, the case is placed back over the model, funnels placed in position and the gelatine poured in. After the gelatine has cooled—this takes from six to ten hours—the case is taken off, dried out with french chalk and the gelatine removed from the model and placed in the case.

The grease is washed off the face of the gelatine, which is thoroughly dried and given a good brushing over with a mild, warm alum solution. This is allowed to rest for three or four hours, given another brush with warm alum solution, and allowed to stand for a further nine or ten hours before it is greased ready for reproducing casts (Fig. 7).

Waste Moulding

A process known as waste moulding is used where a model is heavily enriched and only one reproduction is necessary, or a perfect reproduction needed.

The clay figure is given a very light sprinkling of turpentine or paraffin. Plaster is splashed on to the model with the hand, a brush not being used as it would damage the face of the clay. Irons are cut for reinforcing the mould. When the plaster is set the clay is taken away from the mould in pieces. Having got the face of the mould perfectly clean, it is ready to have the cast filled in in the orthodox manner.

When the cast is set the whole job—cast and mould—is turned on end, the irons in the mould are carefully chopped off and the mould is chipped away from the cast with a chisel.

Piece Moulding

A piece mould is used where a model which is undercut has to be moulded and reproduced more than once, and it is essential that none of the detail or character is lost. In this case, a gelatine mould will not suffice because a certain amount of detail is lost. A waste mould is obviously no use, because more than one reproduction is required.

A piece mould is made in such a way that each piece of the model which is undercut is moulded separately, each piece of the mould being independent yet reliant on the other pieces which fit to it. No two piece moulds are alike and no two men make a piece mould exactly the same.

Template Moulding

To run an ordinary straight plain mould, a zinc template is cut, which gives a plaster mould from which to cast.

Fig. 8 shows the method used to turn a vase or baluster. A box is made up in the same way as for the column. The template is fixed on a spindle, which is continually turned whilst canvas and plaster are added until the mould is complete.

The model is then moulded in halves. When two are cast they are tied together, and wadded down the joints, with canvas soaked in plaster, on the inside.

Fig. 8. Template Moulding.

DISCUSSION

Mr. W. Howell : Is there any way of hardening the surface of cobblestones and paving, to avoid the clouds of dust ?

The Author : Dextrine is used for hardening plaster. Cobblestones are made with sand and cement, reinforced with expanded metal.

Mr. A. H. Ross : Is papier maché ever used in place of plaster ?

The Author : Papier maché is not, I think, used for mouldings. But I have heard of paper moulds being taken from furniture, to be reproduced in plaster, to avoid damaging carved furniture.

Mr. Thomas : If you are taking a mould of a valuable piece of furniture, you can use tissue paper and clay ; you back the clay with plaster, and you have a perfect mould.

COMITÉ INTERNATIONAL DE TÉLÉVISION

A meeting of television technical authorities of various countries took place at Cannes from September 20th to the 23rd, 1947, as part of the Comité International pour la Diffusion Artistique, Littéraire et Scientifique par la Cinéma. The British representative at this Conference was Mr. A. G. D. West, Past-President, who also represented the Society.

Various papers were presented on technical subjects of common interest to television and kinema. These were concerned with international exchange of television programmes, technical standards, television as an aid to the kinema, the kinema's contribution to television, and the development of large screen television for the kinema.

The opportunity was taken to form a Comité International de Télévision (C.I.T.) with Monsieur R. Barthélémy (France), Dr. A. Castellani (Italy), Professor F. Fischer (Switzerland), and Mr. A. G. D. West (Great Britain), as Founder Members.

It is hoped that the work of this Comité will be augmented by the addition of further representative members and by the holding of regular meetings.

B.S.R.A. JOURNAL

The quarterly publication of the British Sound Recording Association, before the war circulated in duplicated form, now appears under the title of *Sound Recording.* The Hon. Editor is Donald W. Aldous, F.R.S.A., M.Inst.E., M.B.K.S.

The first issue, dated Summer, 1947, includes several valuable technical papers, together with reports on the progress of the Society.

FLUORESCENT LIGHTING

W. A. R. Stoyle, B.Sc., A.M.I.E.E.*

Read to meetings of the B.K.S. at Manchester, on the 3rd December, 1946, and at Newcastle-on-Tyne, on 10th December, 1946.

BEFORE 1930 the illuminating engineer, contending only with metal filament lamps, could flatter himself that he knew almost everything concerning electric lamps and their application to lighting.

In a filament lamp only about 8% of the energy is radiated as visible light, the remaining 92% being radiated as heat The colour of the light from a filament lamp is predominantly red, and extremely deficient in blue.

The production of light by the discharge of electricity through certain gases is an extremely complex process. The electric discharge lamp can be considered primarily as an envelope containing a gas such as neon or mercury vapour, into the ends of which are sealed two electrodes ; a suitable voltage applied across these electrodes so excites the gas atoms that multiple collisions take place.

These collisions are so violent that some of the electrons are displaced from their normal orbits and move rapidly towards the positive electrode, colliding with other atoms on the way and resulting in still further electrons being displaced. This process is cumulative and if some impedance is not placed in circuit with the lamp, the electron flow will build up to a catastrophic value.

Many of these displaced electrons recombine with atoms which have lost one or more electrons. It is in this process of recombination that energy is radiated, in the form of radiant heat, as ultra-violet or as visible light.

Discontinuous Spectrum

Unlike a heated metal filament, which emits a continuous spectrum, the radiation from an electric discharge is discontinuous. Only certain wavelengths (or colours) are emitted, each separate gas radiating different colours or combination thereof.

An electric discharge through neon gas results in the type of radiation shown in Fig. 1 and that from sodium vapour is shown in Fig. 2. The visible light from neon is predominantly red and that from sodium predominantly yellow, limiting their application to general lighting.

Neon, sodium vapour and mercury vapour—particularly the two latter—have a high luminous efficiency when compared with metal filament lamps, efficiencies of 50 to 70 lumens per watt being possible with some mercury and sodium vapour lamps.

The most flexible gas from the point of view of the lamp engineer is mercury vapour, whose characteristic radiation when operated at about atmospheric pressure, is given in Fig. 3. With the exception of a low red content, the majority of other spectral colours are radiated strongly and the colour distortion is materially less than with either neon or sodium lamps.

As regards light production in the earlier forms of discharge lamps, much of the invisible ultra-violet energy was completely lost, being absorbed in the glass bulb of the lamp. More recently, however, use has been made of fluorescent powders which when activated by ultra-violet radiation themselves emit visible radiation. It is this principle which is used in the fluorescent lamp, the tubular bulb being internally coated with special fluorescent powders. Variation of the mixture of fluorescent powders enables an almost infinite number of colours to be produced.

Fluorescent lamps of the type described can be divided into two main categories known as hot cathode and cold cathode.

* General Electric Co., Ltd.

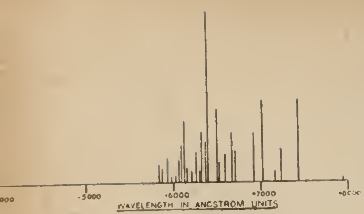


Fig. 1. *Spectrum of Neon.*

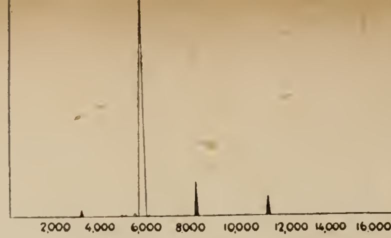


Fig. 2. *Spectrum of Sodium.*

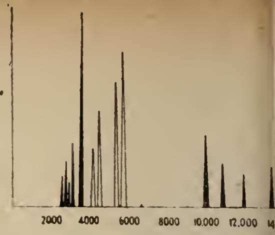


Fig. 3. *Spectrum of Hig Pressure Mercury.*

Hot Cathode Fluorescent Lamps

The particular advantage of the hot cathode lamp is that it can be operated from ordinary mains voltages. Ordinarily voltages of 200 to 250 are insufficient to start a discharge through a tube, say, 4 ft. to 5 ft. long ; but by a combination of thermionically coated electrodes providing an active electron emission and a high voltage impulse, striking is made possible on a relatively low voltage, and once the discharge has been initiated, ordinary mains voltages are quite sufficient to maintain the arc.

A schematic diagram of the lamp and electrode construction is shown in Fig. 4. Plates connected to each electrode act as anodes at each half-cycle of the alternating voltage.

Commercially made lamps of this type are supplied in two ratings, viz., a 5 ft. 80 Watt lamp and a 4 ft. 40 Watt lamp. Initial efficiencies of from 40 to 50 lumens per Watt are possible and the lamps are available in two colours, daylight and warm white.

The normal type of circuit used with hot cathode lamps is shown in Fig. 5, consisting fundamentally of a choke coil to limit the current through the lamp and a special starting switch S.1., which consists of a small helium discharge tube containing one or two bi-metallic strips connected in parallel with the lamp. The mains voltage is insufficient to start the main discharge in the lamp, but the discharge in the helium gas of the glow starting switch heats the bi-metallic strips which bend over and make contact. The circuit is completed through the lamp electrodes, the electrodes are raised to incandescence, and the mercury vapour is ionised. As the starter contacts are now short circuited the bi-metallic strips cool and the contacts open. This breaking of the circuit gives rise to a high voltage surge (caused by the collapse of the magnetic field in the choke coil) which, combined with the excitation of the gas, is sufficient to start the discharge from end to end of the fluorescent lamp.

The other components of the circuit illustrated in Fig. 6 are a small radio-interference suppression capacitor C.1 and the normal power factor correction capacitor C.2.

The introduction of the necessary inductance in the circuit in order to limit the lamp current results in a low power factor of about 0.45, but this can be brought up to about 0.85 by the addition of a suitable capacitor.

Light Fluctuation

One characteristic of all types of electric lamp is that, on alternating current, they have a non-uniform light output as the light drops almost to zero with each half cycle, causing a periodic flicker. In such cases the difficulty can be overcome by arranging some " overlap " of the light from two or more lamps operated from separate phases of the A.C. supply or by use of the two-lamp circuit in which one lamp is operated in series with a choke coil and the other in series with a choke coil and capacitor, this arrangement resulting in the current, and the light output in the two circuits, being 120° out of phase. This circuit has the additional advantage that, as one branch of the circuit has a 60° lagging power factor and the other a 60° leading one, unity power factor is achieved.

Operated under normal burning conditions the average life of this type of hot cathode lamp is of the order of 2,500 to 3,000 hours.

Hot cathode fluorescent lamps, although designed for use on alternating current, can be operated on direct current but with some reduction in life and light maintenance and a considerable reduction in overall economy. A stabilising resistance in series with the lamp ensures that the wattage loss in the resistance will be at least equal to that consumed by the lamp, thereby reducing the overall efficiency of the circuit to about 50% of that on alternating current. Because the mercury gradually drifts towards the cathode, the polarity of the supply must be changed at periodic intervals.

One other method of operation is the use of relatively high frequency supplies of 250 cycles upwards. This enables a simple semi-resonant circuit to be used, the values of inductance and capacity being chosen to cause resonance at starting, the voltage across the lamp builds up to a sufficient magnitude to start the lamp. Operation on high frequency supplies also enables much smaller and lighter auxiliary gear to be used and flicker is more or less eliminated. The need for a starting switch is also eliminated.

Cold Cathode Lamps

Cold cathode electric discharge lamps are constructed with solid or semi-solid uncoated electrodes, starting being effected by the application of

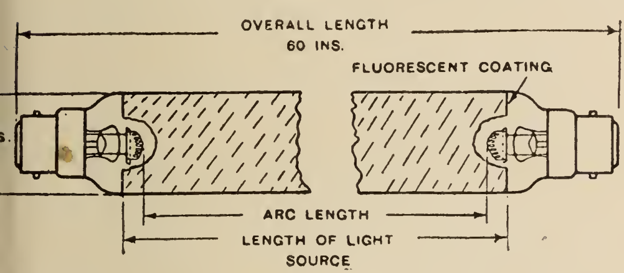


Fig. 4. Construction of Cold Cathode Discharge Lamp.

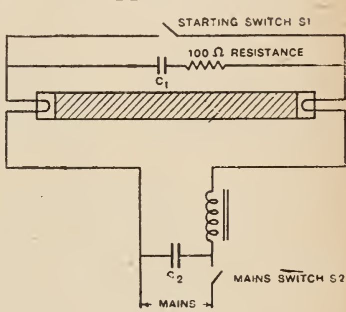


Fig. 5. Circuit for Discharge Lamp.

relatively high voltages. The actual operating voltage is also relatively large so that step-up transformers are necessary. The use of these voltages naturally necessitates special safety precautions. No starting switches are needed and provided that a sufficiently high voltage is available, very long lengths of tube can be operated from a single transformer.

Cold cathode lamps are slightly less efficient than hot cathode, but have a longer average life, which is an important factor where maintenance problems, such as difficulty of access, exist.

The use of three lamps in series affords a convenient means of mixing different coloured tubes and enables many different lighting effects to be carried out.

DISCUSSION

Mr. Wilson : What is the comparative efficiency and candle power per watt ?

The Author : Efficiency of the tungsten filament lamp is 12 lumens per watt. The H.T. discharge type is 30 lumens per watt and the L.T. type is 40 lumens per watt.

Mr. Fraser : On re-striking, does the lamp operate at the same voltage as that at which it is extinguished ?

The Author : The striking voltage is slightly higher than the extinguishing voltage.

Visitor : Is the efficiency of the lamp constant ?

The Author : There is a drop in efficiency in the first 100 hours but after this period the drop in efficiency is very slow.

DEMONSTRATIONS OF NEW SUB-STANDARD EQUIPMENT

At the meeting of the B.K.S. Sub-standard Division on the 28th May, 1947, new apparatus was demonstrated by a number of manufacturers.

The demonstrations were preceded by the projection of the 16mm. film, prepared on behalf of the Society by Messrs. W. A. Buckstone, F.B.K.S., and G. A. Jones, A.R.I.C., M.A., F.R.P.S., for the Physical Society Exhibition, held on April 8, 9 and 10, 1947. The film consisted of the following sequences :

1. *Infra-red film of the accommodation of the pupil to darkness (Kodak, Ltd.).*
2. *Slow-motion (stroboscopic) photography of discharge from a Fuel Jet (Mr. W. A. Buckstone).*
3. *Slow-motion films of Carbon Arcs (G.E.C. Laboratories).*
4. *Microscopic film of Surgical Operation (Messrs. T. E. Cawthorne, F.R.C.S., and E. Gwynne-Evans, M.B., B.S.—apparatus made by Mr. E. Mackie, F.R.M.S., A.R.P.S.).*
5. *Time-lapse film of the Movement of Blood Cells (Mr. R. McVitie Weston, M.A., M.B.K.S.).*
6. *Kine-radiograph of Human Joints (Nuffield Institute for Medical Research).*
7. *Slow-motion film of a Splash (Kodak Research Laboratories).*
8. *Diagrammatic instructional films (Mr. Max J. Kaufmann, M.B.K.S.).*
9. *Take-off of Aircraft, and the recording of Aircraft Dials (Miles Aircraft, Ltd.)*

B.T.-H 16 mm. FILM PROJECTOR, TYPE 301

M. E. Clayton*

THE BTH 16 mm. projector shown in Fig. 1 is the first post war 16 mm. projector of British design. Its excellent all-round performance is combined with an exceptional degree of simplicity and portability.

A high level of screen illumination is obtained by the use of either a 500 Watt or 750 Watt lamp with a high efficiency optical system, the lamp and lamp house being force-draught cooled. Exceptional picture steadiness and complete freedom from flicker have been achieved by the unique design of the intermittent mechanism. Film threading is the simplest yet devised. There are only two sprockets, the sound sprocket being co-axial with the sound drum.

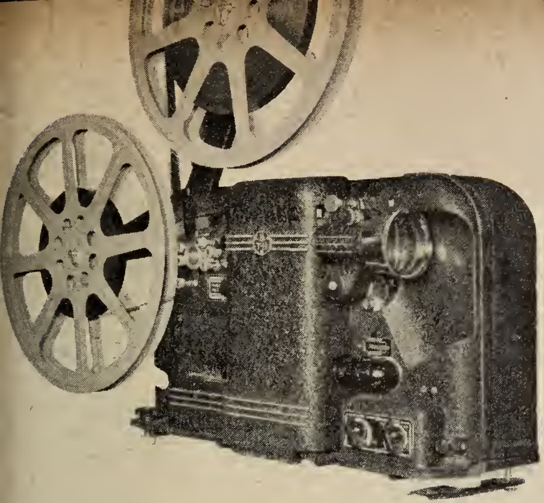
The projector is built on the unit principle so that major parts such as the intermittent mechanism and the amplifier can be removed and replaced in a matter of seconds; this feature together with the extensive use of grease-packed ball bearings and single point lubrication for the intermittent mechanism, makes for the greatest simplicity in servicing.

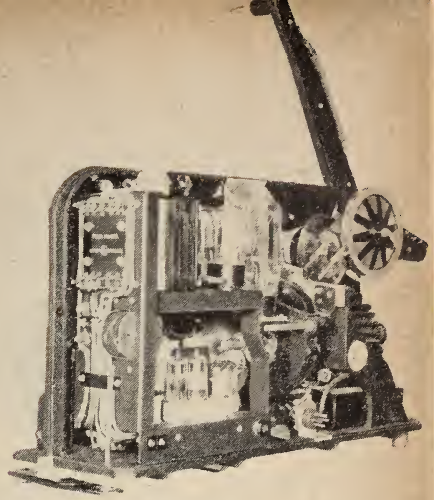
The soundhead incorporates a differential friction drive to the sound drum and a scanning slit only .0004 in. wide. These features ensure a very steady and clear reproduction of sound. The 10 Watt amplifier uses miniature valves, and feeds a 12 in. P.M. speaker, mounted in its own carrying case, which forms an effective baffle when the projector is in use.

The spool arms are built-in and are capable of handling 2,000 feet of film. The instantaneous tilt adjustment can be seen under the front of the projector. All controls for the amplifier and projector are grouped on the same side of the machine. Just below the feed spool can be seen the combined feed and take-up sprocket, also the gear speed change lever for silent film projection.

Electrically interlocked switches are provided whereby it is impossible

* British Thomson-Houston Co., Ltd.





to switch the projector lamp on before the motor and blower are running.

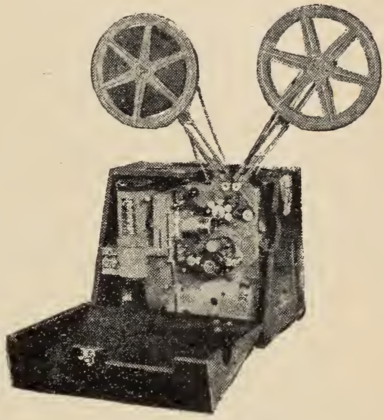
The complete equipment is housed in two carrying cases, one containing the projector, and the other the speaker, 50 feet of speaker cable, and a spare spool. The mains transformer is also housed in this case for transportation.

Dimensions and weights are as follows :

Projector carrying case ...	23 in. $\times 8\frac{3}{4}$ in. $\times 12\frac{1}{2}$ in.
Speaker carrying case	$23\frac{1}{2}$ in. $\times 8\frac{3}{4}$ in. $\times 15$ in.
Weight of projector unit only	39 lb.
Weight of projector unit in case	58 lb.
Weight of speaker and mains unit in case	50 lb.

THE VICTOR PROJECTOR

H. T. O. Culliford*



COMPLETE protection against film damage is one of the features of the Victor Animatophone 16 mm. sound-on-film projector. A trip device is incorporated at every point where emergency might arise. Damage to film perforations is entirely prevented by the use of pawls which spring over the film to engage the holes, and the picture shift is relatively slow.

The swing-out lens mount permits of easy cleaning of the film channel and aperture. Side guidance of the film in the gate is effected by an offset loop, which ensures the film flowing naturally to one side of the gate, and thus prevents picture weave.

The motor-driven fan forces the draft in a spiral path around the lamp and between the multiple walls of the lamphouse, ensuring a long lamp life and allowing the most powerful lamps to be used with perfect safety.

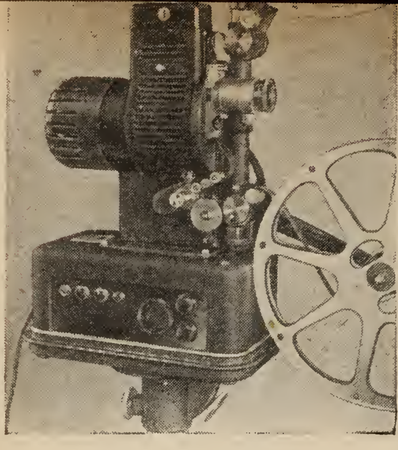
No prisms are employed in the sound optical system. Variable voltage control of the photo-cell assures high efficiency and long cell life.

The power rewind is fast, positive and convenient and does not necessitate the changing of reel positions before rewinding.

A minimum number of controls are employed, all of which are well marked, accurate and positive in action.

The projector is designed to operate on 110 volts A.C., and a step-down transformer is provided to suit any mains voltage.

* Victor Animatograph Corporation (London) Ltd.



THE "DEBRIE 16" PROFESSIONAL

G. A. Nightingale*

THE "Debrie 16" projector is an open professional machine designed for operation on A.C. from 220/250 volts.

The 750 watt projection lamp is also used as an exciter for the sound head. The intermittent mechanism gives a 60° movement with a minimum of film wear. Drive is by means of a split-phase motor, and is geared throughout, making spring belts or chains unnecessary.

The film is thoroughly smoothed before scanning by an adjustable three-roller assembly, and flutterless reproduction is ensured by a sprung compensator interposed between the take-up sprocket and the sound drum. The sound drum itself can be removed instantaneously for cleaning, thereby exposing the prism. Sound scanning is carried out by a compensated optical unit, and the width of the scanning beam is .0005 in. Large diameter (16 tooth) sprockets are used, obviating jockey rollers.

Lubrication is fully automatic, oil being pumped from the lower to the upper chamber, from which it is fed visibly to the mechanism and gears, and returned to the sump.

The amplifier has an output approaching 30 watts, and two tone controls are provided, bass attenuation and treble boost. Telephone type jacks are provided, one for mic/gram. input and the other for monitor speaker input. The main speaker is a 12 in. p.m. type, efficiently baffled, and the speaker case is designed to reduce cabinet resonances to a minimum.

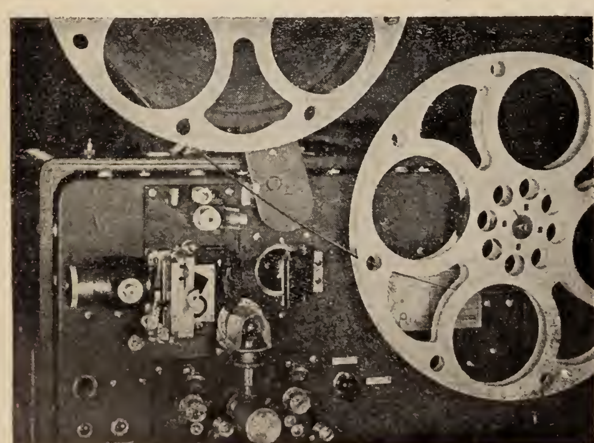
The machine is finished in matt chrome and black crackle enamel, and is supplied in two substantial carrying cases. A fully adjustable duralumin tripod is also available. This has a pan-tilt action and can be locked in any position.

* Cinetechnic Ltd.

CARPENTER PROJECTOR

S. L. Carpenter, M.B.K.S.*

ONE of the many novel features of this projector is the left-hand threading; mechanically this has several advantages: the claw motion is close to the main panel, ensuring rigidity, while the sound track is on the outside, thus permitting direct scanning. The drive is by means of two high-speed synchronous motors, one driving the main mechanism and the other a small blower; the latter is also used for rewinding. The projector has sound and silent speeds.



The pull-down ratio of one to five leads to less wear on the film. A triple claw assists in passing damaged film. Spool arms carry 2,000 ft. of film.

* Carpenter & Richardson, Ltd.

The lamp-house accommodates 110 v. lamps of up to 1,000 watts. Coated lenses assure maximum screen brightness.

The amplifier gives an undistorted output of 25 watts. Tone control gives attenuation of bass and treble. Microphone and pick-up jacks are provided.

VISIBLE EDGE NUMBERING MACHINE

R. B. Paine, M.B.K.S.*

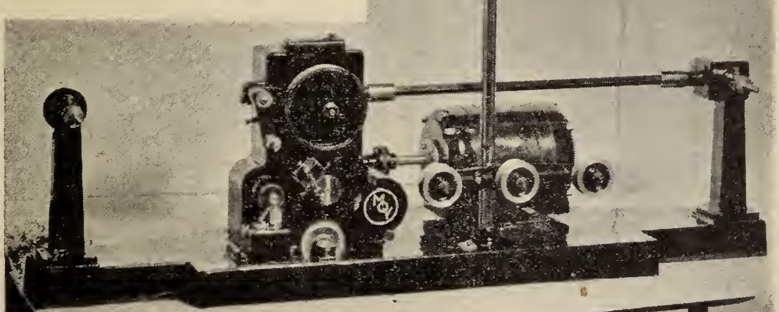
THE Moy 16 mm. Visible Edge Numbering Machine is an adaptation of the standard machine. In the past, 16 mm. equipment has seemed to be of much too flimsy a character ; too much attention has been paid to the building of equipment suitable for the amateur. This growing and important section of the industry deserves equally as good equipment as its standard counterpart. In this machine an attempt has been made to provide it.

The movement of the film is continuous, *i.e.*, non-intermittent. Numbering is carried out by a revolving numbering head rotating at the same speed as the 40 toothed driving sprocket—1 revolution of the sprocket being 1 foot of film. Inking is obtained by a capillary feed wick on to an inking roller. The cap provided should be placed over the wick immediately the actual process of numbering is completed to prevent the wick hardening, owing to the rapid drying of the ink ; for this purpose the inking chamber can be slid sideways clear of the inking roller.

The numbering stamp is easily removable from the numbering head ; at the end of each day's working this is removed and washed out to prevent clogging. The film is numbered on the inside edge between the perforations on the emulsion side. The size and type of character can be varied within reason to suit individual requirements ; the usual head consists of a total of 6 letters and numbers. The stamp changes once in each revolution automatically. A gear driven brush is provided together with a cleaning roller, and the complete cycle is :

1. Brush the stamp.
2. Clean the stamp.
3. Ink.
4. Number the film.

After numbering, the film passes over a number of drying rollers in order that the ink may dry before taking up.

The machine will accommodate up to 2,000 feet and runs at a speed of 50 ft./min. Motors can be supplied to suit any voltage either A.C. or D.C. A central oiling point feeds oil to the gears and spindle in the main head.

* Ernest F. Moy, Ltd.

Negative as well as positive film can be used, the ink being dense enough to print through if required. The supply coupling is by "Niphan" plug suitable to take metallic flexible tubing, and a built-in switch is provided.

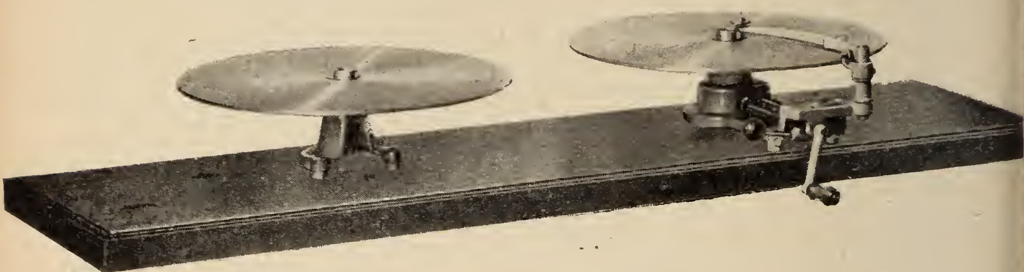
The general finish is a high quality black enamel, brass parts being chromium plated and polished.

HORIZONTAL REWIND UNIT

R. B. Paine, M.B.K.S.*

THE earlier remarks regarding equipment have been to the fore in designing this horizontal rewind unit. The result is a robust piece of equipment capable of withstanding a considerable amount of rough usage.

The winding table is of cast aluminium, well ribbed for stiffness, the top face being turned to a smooth finish. The steel spindle carrying the table

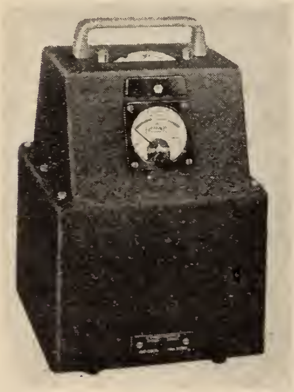


runs in a self-lubricating bearing and both spindle and table are supported on a special ball race. The drive is by bevel gears of $2\frac{3}{4}$-to-1 ratio. A retractable centre is withdrawn by means of the lever situated near the winding handle enabling the reel of film to be slid off the table. Standard bobbins can be used if desired. Oiling points are provided where necessary. A spring loaded arm ensures even winding of the film.

The unwind table is of similar construction, but is provided with an adjustable friction disc to prevent over-running. The main castings of both units are in iron. It is preferable that these units be mounted underneath the work bench, with the tables standing just clear of the top face, and for this purpose the tables are easily removable from their spindles. They can alternatively be mounted on top of the work bench. Both units will accommodate 1,600 feet of film.

INTELINC TRANSFORMER FOR 16 mm. PROJECTORS

R. A. Smith†



FOR use with sub-standard 16 mm. kinema projectors, Intelinc supply an illuminated Perspex voltage selector providing instantaneous control of screen brightness during projection.

There is a shaded lamp for commentaries, and inspection and repair of film, also an accurately calibrated, floodlit voltmeter, which permits a continuous check on correct operating voltage—of first importance to a bright picture and good sound.

The apparatus is designated Type D.A. 8/1 for use on 190-250 v. A.C. mains. Its rating is 1,000-1,250 watts.

* Ernest F. Moy, Ltd.

† Intelinc Ltd.

TECHNICAL ABSTRACTS

Certain of the following abstracts are reprinted by courtesy of Messrs. Kodak Ltd. Most of the periodicals abstracted may be seen in the Society's Library.

METHOD FOR SHARP FOCUSING.

G. Korff, Z. *Instrumentenkunde,* **63,** April, 1943, pp. 121–125.

A special test object is suggested for use in focusing a camera under conditions where depth of field is important. Two parallel-line objects are mounted some distance apart and in such a manner that the bars of one chart correspond to the spaces in the other chart. It is stated that the position of correct focus is then obtained when the image of the test object shows a doubling of the number of lines. G. C. H.

MULTIPLANE SETS FOR FILMING WITH MODELS.

G. A. Gauld, *Movie Makers,* **20,** October, December, 1945, pp. 385, 400–402, 491, 498–500 ; **21,** February, April, June, 1946, pp. 62–63, 82–84, 146, 154, 224, 232, 234–236.

The article is the first of an authoritative series of articles published on this relatively new motion-picture technique used chiefly in making Disney cartoons. *Part* 1. This article gives general information about the building of model sets wherein the models are made in different sizes and placed in different planes relative to the camera lens, but so scaled as to give correct relationship to each other in the picture. It is noted that when filming is complete, the scene, including the models, appears to have greater depth and naturalness than would otherwise be obtained. Detailed information is given on the determination of object size and the technique of building model sets. *Part* 2. This article continues with information on the model set building, following one idea through in fairly complete detail. A table is given showing field sizes obtained with supplementary lenses of varying dioptre ratings. *Part* 3. This chapter discusses the relationship of the parts of the set to what the observer sees, and tells how to attain the maximum naturalness in the illusion. Included are formulae and perspective details. *Part* 4. This article provides a number of graphs giving a scale of planes on which models should be constructed, and also the scale of distances of objects from the camera. *Part* 5. This article includes final details on the design, construction, and use of miniature multiplane sets for use in filming small models. All five articles are adequately illustrated with drawings, graphs, tables, and formulae. H. B. T.

PROJECTION BY PIN POINT.

U.S. Camera, **9,** No. 5, June, 1946, pp. 25, 51.

The article is an account of a comparison made between a concentrated (zirconium) arc and the conventional tungsten lamp, in both an 8 mm. motion-picture projector and a 2-inch by 2-inch slide projector. For lamps of comparable wattage, the arc produced higher screen illumination, better contrast and definition, one hundred times longer lamp life, less heating, and was more rugged. With a proper optical system, larger screen images can be obtained with the arc. These new lamps are not usable in present projectors, different lamphouses and optics being required. The cost and weight of the power unit is one present disadvantage. J. W. McF.

FREQUENCY RESPONSE OF MAGNETIC RECORDINGS.

Otto Kornei, *Electronics,* August, 1947, p. 124.

The article in reality describes the frequency response of the reproduction of a magnetic record. In reproduction for very low wave lengths a rising frequency characteristic of 18 db per octave is mentioned, but when the wave length is of the medium audio frequency range a slope of 6 db per octave is obtained. The frequency response, however, does not correspond exactly to the 6 db slope at the upper end of the audio frequency range, but various factors and their influences are discussed, the most important of these factors being the demagnetization, the penetration and the gap effect.

The demagnetization effect depends entirely on the physical shape of the magnets and increases with rising frequencies. The penetration effect depends on the thickness of the material and lower frequencies have a deeper penetration than higher frequencies. The gap

effect is the loss due to the finite width of the magnetic gap in comparison with the wavelength ; this effect is similar to the slit loss in photographic recording.

The author then compares homogeneous magnetic media with powdered magnetic material on tape and comes to the conclusion that for a given frequency response the magnetic tape can be run with roughly half the speed required for the wire. The reproducing level from magnetic tape is inherently low, but this difference can be compensated by using a correspondingly wider recording track. O. K. K.

RECENT DEVELOPMENTS OF SUPER-HIGH-INTENSITY CARBON-ARC LAMPS.

M. A. Hankins. *J. Soc. Mot. Pic. Eng.*, 1947, p. 97.

A trim consisting of a 16 mm. positive and a copper-coated negative 17/32 inches diameter, burning at 225 ampères, 75 arc volts gave high intrinsic brilliancy (700 candles/sq. mm. maximum), uniform brightness of a comparatively large area of the crater face, and steadiness of burning.

For process projection, the lamp designed to take this trim is fitted with a watercooled positive head. The positive feed is controlled by a photronic cell ; the negative feed keeps the arc length correct when burning and strikes the arc. A resistance grid enables the arc to be run at currents of 150, 180, 200, 225 ampères.

For studio lighting the same trim is burnt in a lamp fitted with a 24 in. diameter Fresnel-type refractor. The luminous flux from this lamp is approximately double that of the 150 ampère studio spotlight. F. S. H.

G.K.-21 PROJECTOR.

R. H. Cricks, *Ideal Kinema*, Feb., 1947, p. 19.

A streamlined appearance characterises a self-contained unit, features of which are the parallel opening gate ; built-in change-over system and carbon dioxide fire prevention system ; 16 in. arc mirror, giving an over-all aperture of *f*/1.8 ; and totally enclosed easily accessible wiring connections. AUTHOR'S ABSTRACT.

B.T.-H. SUPA PROJECTOR.

Ideal Kinema, March, 1947, p. 23, April, 1947, p. 19, Oct., 1947, p. 25.

Features of the new B.T.-H. projection unit are the massive mute head, built integrally with the sound head, the latter with eddy-current smoothing ; completely automatic arc ; built-in change-over device ; optical system with *f*/1.85 aperture. The amplifier is contained within the stand of one unit, and the arc control circuits inside the other. R. H. C.

THE PROJECTION LIFE OF 16 mm. FILM.

C. F. Vilbrandt, *J. Soc. Mot. Pic. Eng.*, June, 1947, p. 521.

The relationship between tension on the film at the sprockets and wear of the film are considered for both drive and hold-back sprockets. The paper shows that film wear is much greater on drive than on hold back sprockets with the same film tension. The conclusions reached are supported by laboratory tests. H. S. H.

EFFECT OF TIME ELEMENT IN TELEVISION PROGRAM OPERATIONS.

Harry R. Lubcke, *J. Soc. Mot. Pic. Eng.*, June, 1947.

This paper probably breaks new ground in that it is one of the first non-electronic papers on television operation. It deals with the essential difference between the film and television studio and although the paper is short it describes the " preset " principle developed by the Don Lee Television Studio in Hollywood.

The author's first point is that a great deal is accomplished in the smooth performance of a television programme by having a well written script. Next it is important to arrange the studio sets so that continual and rapid movement of cameras, microphones and essential lighting can be carried out during the performance. Finally he emphasises the necessity for a trained engineering and production crew, each member of which knows his part to perfection and unselfishly co-operates with his crew mates. All this is essential to maintain the principle that once the television programme has started the show must go on to the end. There is no time for re-takes and recriminations and no breaks for anyone—production staff, camera crews, floormen or engineering staff. T. M. C. L.

THE COUNCIL

Meeting of 8th October, 1947

Present : Messrs. I. D. Wratten (*President*), E. Oram (*Hon. Secretary*), P. H. Bastie (*Hon. Treasurer*), C. H. Champion, B. Honri, L. Knopp, A. W. Watkins, A. G. D. West (*Past President*), R. Pulman (*representing Theatre Division*), H. S. Hind (*representing Sub-Standard Division*), G. Burgess (*representing Film Production Division*), R. H. Cricks (*Secretary*).

Branch and Divisional Constitutions.—Draft constitutions of Branches and Divisions, as approved by the Society's solicitor were submitted. It was agreed that the Theatre Division should further consider the formation of Branches and fix a minimum membership.

Foreign Relations Committee.—Where currency restrictions prevented remittances from would-be subscribers, it was decided to forward a number of Journals abroad free of charge. The formation of foreign branches at the present time was not approved.

Mr. West reported that he had represented the Society at the Press Conference in connection with the Cannes Film Festival and that a Comité International de Télévision had been formed.

Film Mutilation Committee.—Mr. Knopp reported that he was convening a meeting between the K.R.S. and the C.E.A. and that agreement had been reached between these authorities for the production of brochures.

Home Office Regulations.—It was decided that the Society should offer its services to the Home Office as an impartial adviser.

Sub-Standard Division.—It was decided to convene an early meeting of the Committee set up to consider the programme for the Physical Society Exhibition.

EXECUTIVE COMMITTEE

Meeting of 8th October, 1947

Present : Messrs. I. D. Wratten (*President*), E. Oram (*Hon. Secretary*), P. H. Bastie (*Hon. Treasurer*) and R. H. Cricks (*Secretary*).

Elections.—The following were elected :—

William Smith McInally (Member), Associated British Cinemas, Ltd.
John Henry Jordan (Student).
Edward Clayton (Member), Middlesex Cinemas, Ltd., Middlesex.
Alexander Charlozinski (Student), Regent Street Polytechnic, W.1.
George William Ashton (Student), Regent Street Polytechnic, W.1.
Norman Arthur Kerridge (Associate), Associated British Cinemas, Ltd.
Donald Ian Dalgleish (Student), Regent Street Polytechnic, W.1.
John Meredith Haybittle (Student), Regent Street Polytechnic, W.1.
William Edward Johnson (Student), Regent Street Polytechnic, W.1.
Karl Herbert Carter (Member), Alliance Studios, Chiswick.
Kenneth Edmund de Warrenne Waller (Student), Twickenham Studios.

Transfers.—The following were transferred from Associates to Corporate Members :—

Arthur William Smith, Wray (Optical Works), Ltd.
Edward Gardiner, Odeon Theatre, Henley-on-Thames.
Leslie Stuart Baker, Army Kinema Corporation, North Circular Road, N.W.10
Henry Cyril Brockwell, Crown Film Unit.
Walter Ralph Dolbear, British Lion Studios.
Alfred John Pauley, D. & P. Studios, Ltd.
Walter Ernest Saunders, Ilford, Ltd.
Howard Thomas, Pathé Pictures, Ltd.
Cyril Worthington Botham, G.B. Equipment, Ltd.
Ronald David Hallett, D. & J. Peters, Ltd., Hatton Wall, E.C.1.
William Stephen Dalby, Ealing Studios, Ltd., W.5.
Jack Stanley Gregory, Odeon Theatre, Leicester Square, W.C.2.
Albert Charles Hammond, Merton Park Studios, S.W.19.

BRITISH STANDARDS

The following British standard specifications have been issued. Copies are obtainable, price 2s. each (No. 1384, 4s.) post free, from the British Standards Institution, 28, Victoria Street, S.W.1.

*B.S.*1112 : 1947—*Sizes of Photographic Paper.*—Sizes and tolerances for photographic paper, from 5×7 cm. to 20 ins. × 24 ins., are specified.

*B.S.*1359 : 1947—*Photographic Conversion Tables.*—Comprises 15 tables of conversion factors between English and metric units, and conversion tables between Centigrade and Fahrenheit.

*B.S.*1380 : 1947—*Speed and Exposure-index of Photographic Negative Material.*—Specifies method of measurement of photographic speed, based upon the point on the log E axis of the curve at which the gradient is 0.3 times the average gradient for an exposure range of 1.50, of which E is the minimum exposure. Arithmetic and logarithmic speed indices are derived from the speed, the latter being measured in degrees.

*B.S.*1384 : 1947—*Measurement of Photographic Transmission Density.*—The term "British Standard Diffuse Density" is defined as the density determined under the geometric conditions provided by any one of three methods described : the integrating-sphere method, the opal-glass method, and the contact-printing method.

*B.S.*1404 : 1947—*Screen Brightness for the projection of 35 mm. Film.*—Specifies a screen brightness between 8 and 16 foot-lamberts. A lengthy appendix describes the experimental work which led to the fixing of this standard. Black-and-white and Technicolor films, each about 400 ft. in length, were projected at various screen brightnesses, and comments were elicited under the following headings :

1. Visibility of grain.
2. Appearance of flicker.
3. Incidence of glare.
4. Specific comments on individual subjects.
5. General quality of projection.

The findings under Nos. 1, 2 and 5 were plotted in the form of curves, from which it appeared that optimum results were obtained at the following brightnesses :

Black-and-white : Min. 12 ; Max. 24.
Technicolor : Min. 7 ; Max. 14.

The choice of a figure between these values, weighted on the low side to avoid running into difficulties with grain in black-and-white, finally led to the recommendation given. It is emphasised that if the possibility of using a denser print is considered, the upper limit may well be extended with advantageous results, but while a brightness in excess of 30 foot-lamberts can only be achieved in certain special theatres with equipment available at present, it did not seem necessary to investigate this aspect of the problem.

BOOK REVIEW

WORKING FOR THE FILMS. Edited by Oswall Blakeston. Focal Press, 204pp. 10*s.* 6*d.*

Nineteen star personalities of the film industry have come forward to tell the reader what they do to produce the finished article. They each tell their story in their own words—how much goes in to produce a picture.

The public, which is always of an enquiring nature, will appreciate this opportunity of reading the story—" of working for the Films and all it entails." A most interesting *Vade Mecum* of the Film Industry.

I venture to prophesy " Working for the Films " will find many admirers in the motion picture studios who will value such first hand information.

REX B. HARTLEY.

PERSONAL NEWS of MEMBERS

Members are urged to keep their fellow members conversant with their activities through the medium of the Journal.

G. R. BELL, formerly of G. B. Kalee, Ltd., has left the film industry to take up a position with an aluminium company in Montreal.

FRANK BUSH of Technicolor, Ltd., shortly going to Hollywood on a visit, hopes to be back in this country by Christmas.

A. CAVALCANTI has been elected a Fellow of the Royal Society of Arts.

T. E. EASTAFF has resigned from Odeon Theatres, Ltd.

C. E. FIELDING has been appointed Chief Engineer to Associated British Cinemas, in place of the late W. MacInally.

B. HAPPÉ of Technicolor, Ltd., has left on a visit to the Technicolor Motion Picture Corporation, Hollywood.

REX B. HARTLEY, recently elected F.B.K.S., has been further honoured by election as a Fellow of the Royal Society of Arts.

A. G. D. WEST has sailed for the U.S.A. where he is to deliver a paper, and to represent the B.K.S., at the Society of Motion Picture Engineers' Convention.

THE JOURNAL OF THE BRITISH KINEMATOGRAPH SOCIETY

1947

Volumes 10 and 11

the latter of which is entitled

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THE BRITISH KINEMATOGRAPH SOCIETY
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BRITISH KINEMATOGRAPHY

The Journal of the British Kinematograph Society

VOLUME ELEVEN, No. 6. DECEMBER, 1947

THE FILM IN RELATION TO TELEVISION

Marcus Cooper, M.B.K.S.*

Read to a joint meeting of the British Kinematograph Society and the Television Society on February 12th, 1947.

WE who belong to the B.K.S. or the Television Society are vitally interested in the manner in which television and motion pictures will get on together. We want to know whether they will each go their independent ways, whether they will marry and live happily ever afterwards, or whether as they seem to be doing at present, they will just go on living in sin.

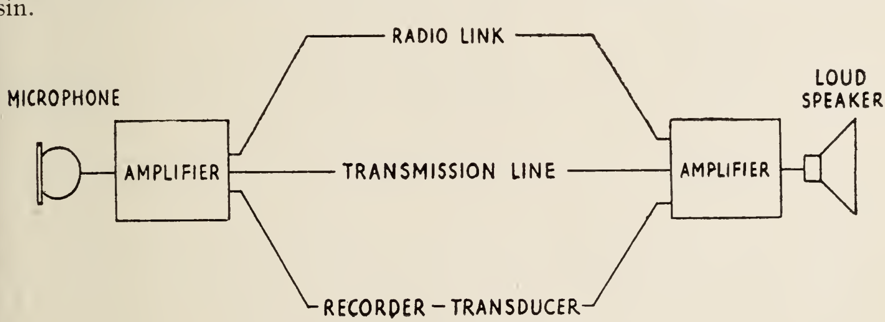


Fig. 1. Elements of a Sound Transmission System.

No one at the moment can give the answer to such questions, and it is certainly not the purpose of this paper to do so.

1. MOTION PICTURE COMMUNICATION SYSTEMS

In order to see how television fits into what one may term Motion Picture Communication Systems, there are one or two elementary conceptions which are helpful.

For example, there is a rather loose analogy with sound transmission systems (Fig. 1.) In the latter, we have an acoustic pick-up device which we call a microphone, and also an amplifier system. The resulting alternating current is sent *via* a line or radio link either directly to reproducing equipment, or to the intermediary of a recording machine. In the latter case, after a time interval the record itself may be played, and the resulting signal passed once more to a transmission line. The recording process can thus be regarded as delayed transmission.

Equally, it should be possible to regard television and films as part and parcel of motion picture communication systems. Unfortunately, when we

* Marcus Cooper, Ltd.

attempt to do this, the electrical transmission process becomes mingled with the photographic one, and each seems to have restricted applications.

When we attempt to express such systems in the form of block diagrams, the comparison is also unsatisfactory.

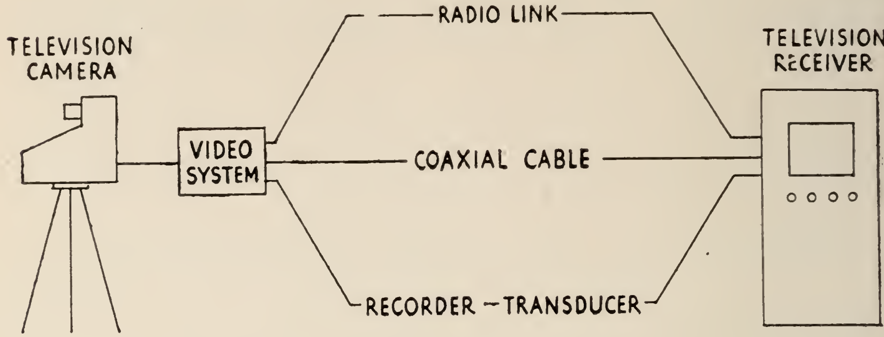


Fig. 2. Elements of a Motion Picture Transmission System.

Returning now to motion picture systems, on the pick-up side, the ordinary kinematograph camera has been used as the first stage in a television system. This has now given way to the purely electronic camera.

On the pick-up side of *films*, we are at present using only the ordinary photographic process.

As far as reproduction is concerned, television uses the fluorescent screen of a cathode ray tube for both direct viewing or projection, or electrically modulates a light beam as in the Scophony system. Ordinarily, of course, motion picture film also modulates a light beam, although not electrically.

Analogous thinking can sometimes be misleading, but it is interesting to draw out " the shape of Motion Picture Communication Systems to come," based on an analogy with sound.[1] (Fig. 2.)

Such a layout for Motion Picture Communication Systems is unlikely to be workable for another five to ten years, and it may be much longer still before the very practical kinematograph camera is replaced entirely.

Nevertheless, as the television system simplifies, and approaches more nearly the photographic process in the matter of picture quality, one cannot help feeling that such a layout is the ultimate logical basis.

Fig. 3. Effect of Lens Aperture on Definition.

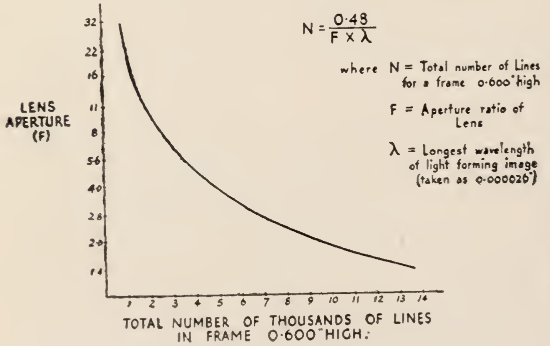
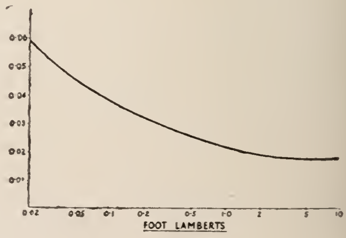


Fig. 4. Contrast Sensibility of the Eye (Konig and Brodhun).



Basic Properties of a Picture Pick-up Device

The three basic properties of any picture pick-up device are :

1. Resolution.
2. Sensitivity.
3. Contrast discrimination.

Resolution is something that is in everyone's mind as far as picture transmission is concerned. Sensitivity is obviously important but can often be met in practice by increasing illumination and lens apertures. Contrast discrimination is, however, all too often overlooked and is obviously a necessary parameter in the expression of overall picture quality. Clearly, a large number of lines to the inch is of little use if the contrast discrimination is zero.

The Criterion of Picture Quality

Whenever the relationship of films to television is discussed, almost invariably the question of relative picture quality arises.

How good has a television picture got to be before it is up to 35 mm. film standard ? Is the present television service giving a picture as good as 16 mm. films can give ?

Effective Number of Lines

Let us first consider the question of the effective number of lines attainable in the two media under discussion.

The first point of interest is the lens. One hears so much about the loss of definition of a lens when it is worked at small aperture, that it is profitable to see just what this means in terms of number of lines.

Taking a 35 mm. kinematograph camera, let us suppose that we have available a theoretically perfect thin lens whose definition is limited only by diffraction phenomena. Such a lens can produce image detail whose structure is expressed in lines per inch by the formula[2] :

$$N = \frac{0.48}{F \, . \, \lambda}$$

where N = the number of lines per inch,
F = aperture ratio of lens,
λ = longest wavelength of light forming the image.

For a 35 mm. film frame which is 0.6 inches in height, we can introduce the factor of 0.6 into the above formula and obtain the expression for the total number of lines. The curve of Fig. 3 has been worked out for red light, taking the wavelength as 0.000026 inches.

It is clear from this curve that if we work our lens at the small aperture of *f*/32, the image structure will be comparable with that of a 600-line television system. For the larger aperture, however, the diffraction effect is hardly a factor. For a lens operating under optimum conditions, the resolution may be as high as two thousand lines per inch.

Resolution of Film Stock

Let us now look at the limits of resolution of our film stock. (Table I.)

If we accept the figures given by A. Cox[3] in his book " Optics," Super XX is capable of resolving 1400 lines per inch, Plus X, 1750 and Panatomic X, 2150.

Multiplying these figures by the frame height tells us the total number of lines given in the two right-hand columns.

In view of the excellent definition of present-day motion pictures, and by comparison with television reproduction, it is at first remarkable that these figures are no higher.

To sum up, the limiting resolution of the photographic process to the practical cameraman is the emulsion itself, and in this connection, the 35 mm.

film frame has the equivalent of about 1000 lines in the vertical direction on an emulsion such as Plus X.

I have, unfortunately, no data to hand as to the loss in resolution due to printing.

As far as the picture you see in the kinema is concerned, there is an increase of definition brought about by the ability of the eye to store up and integrate a number of frames.

The emulsion grains, unlike the lines of a television image, are randomly distributed and occur in different positions on successive frames. Thus, fine detail tends to re-form as one adds together in the eye the results of two or more pictures. It is, I think, this which in part accounts for the fact that when we try to enlarge a frame from a first-class kinematograph negative, we are disappointed with the result as compared with the projected motion picture.

Finally, in this attempt numerically to compare television quality with that of film, there is the fact that we do not obtain a full 405-line picture on our television screen. (Neither, by the way, have I ever seen a television picture on any privately owned set that compares in quality with that obtained on the closed circuit monitors at Alexandra Palace.)

First of all there is the interval between the successive frames of a television image during which some of the lines are lost. This interval corresponds to ten lines, leaving a maximum of 192.5 active lines per frame, or 385 active lines per complete interlaced picture[5].

TABLE I.

Resolution of Film Stock.

Film Stock	Lines per inch	Total Number of Lines 35 mm.	Total Number of Lines 16 mm.
Super XX	1400	840	396
Plus X ...	1750	1050	495
Panatomic X	2150	1290	610

Effective Vertical Resolution of Television Image

Imagine now that the picture to be transmitted is a horizontal stripe pattern consisting of alternate black-and-white stripes. The scanning spot has appreciable width and if its size approaches that of the picture pattern it is just as likely that the scanning spot will fall half-way between two stripes as exactly on one of them[4].

In the very unlucky case of the scanning spot being the width of one of these stripes, and also equally overlapping two of them, the resulting picture would be an intermediate grey tone devoid of detail.

Of course, this is an extreme case, since in practice a picture consists of a scattered distribution of different degrees of light and shade. There will, however, be many instances in a typical picture where this effect occurs, and the question is, what is the average effect of this on the whole picture in terms of reducing the effective number of scanning lines?

An investigation into this matter by Engstrom[7] based on practical experience, indicated that no more than 64% of the picture elements are, on the average, correctly reproduced in the scanning process.

If this is so, we must multiply our 385 active lines by a reduction factor of 0.64. This gives present B.B.C. television an effective number of lines of only 246, and helps to explain the superiority of photographic emulsions which, as we have seen, ordinarily cannot resolve more than about 1,000 lines in a 35 mm. frame.

Picture Contrast

From the foregoing remarks it is clear that we must accept the given number of lines of a television system with certain reservations as far as picture goodness is concerned.

Nor does the number of lines of a picture tell us anything about contrast. Clearly a picture of a thousand lines is of poor quality if its contrast range is very low.

It has been stated that the contrast obtainable in present-day television is of the order of 12 : 1, and that that attainable by a well-graded motion picture is about 50 : [16]

It is known[10] that at a given illumination level (say of the order of 10 ft. candles) the eye can perceive a contrast ratio of 500 : 1. It is also known[9] that at this illumination level the eye can distinguish between two shades of

TABLE II.

Criterion of Picture Goodness in Terms of ability of Eye to distinguish shades of Grey and also the Picture Resolution.

Medium	Brightness Range	Perceivable Steps	Effective Lines	Goodness
405 Line Television ...	12 : 1	105	246	6.7×10^6
35 mm. Film (Plus X) ...	50 : 1	165	1050	180×10^6
16 mm. Film	50 : 1	165	495	41×10^6

Note.—" Goodness " is taken as Product of Square of No. of Lines multiplied by No. of Steps.

grey whose reflection coefficients differ by a ratio of no more than 1.018. This being so, it can easily be calculated that the eye is capable of distinguishing something between 300 and 400 different tones of grey at such an illumination level.

This contrast sensibility of the eye is depicted in Fig. 4, the abscissæ of which are marked in foot-lamberts, and the ordinates in contrast sensibility.

Contrast sensibility is expressed as the ratio of the sum of the least perceivable increase in brightness and the original brightness level, to the actual increment.

Expressed mathematically :—

$$\text{Contrast Sensibility} = \frac{dB}{B + dB}$$

where $B + dB$ is the stimulus which can just be distinguished from B.

Let us assume that the highlights of a typical kinema screen picture reflect back to us ten foot-lamberts, and that at that particular adaptation, the eye

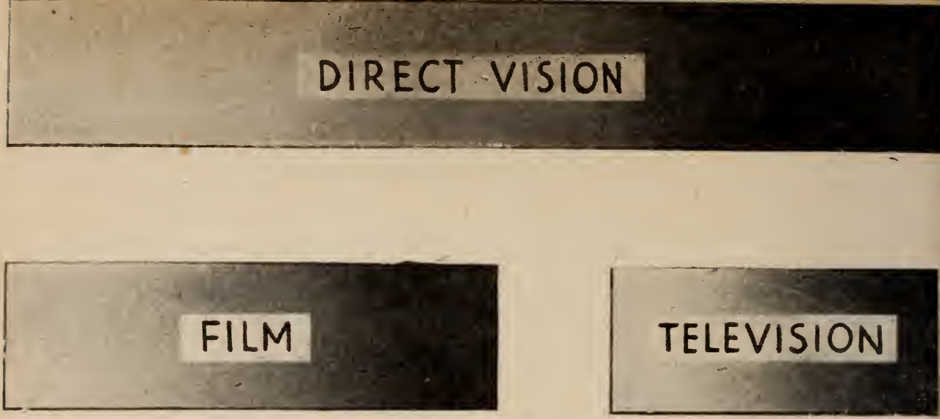


Fig. 5. Sensibility of the Eye to detect different shades of Grey.

can perceive a contrast range of 500 : 1. Then according to the researches of Konig and Brodhun,[9] the eye will be able to distinguish between two shades of brightness which have a ratio of no more than 1.06 at the lower level of illumination, and between two shades of brightness whose ratio is no more than 1.018 at the higher illumination level.

If we assume that the average value for this range of illumination is 1.024, then it can be calculated that for the above conditions the eye can perceive 165 different shades.

With a television picture of equal brightness, the eye could be expected to distinguish no more than 105. As the highlights of most home television sets are of a lower brightness level than 10 foot-lamberts, this figure is on the generous side.

These results are depicted in the accompanying Fig. 5.

Limitations of Television Image

You will have seen, therefore, that present-day 405 line television is suffering from certain severe limitations as compared with kinematograph film.

These limitations are :—

(i) Smaller number of picture elements.
(ii) Smaller contrast range.

One of the points I have endeavoured to make is that the contrast range is just as important in conveying information in picture form as the number of picture elements. One should therefore be justified in calculating the potential number of steps perceivable by the eye in a motion picture communication system, and then expressing the goodness of a picture as the product of the maximum number of grey shades and the square of the number lines. (Table II.)

Set out in this way, it would seem as if television has still a long way to go before it reaches the standard of its photographic brother.

II. THE FILM IN THE TELEVISION STUDIO

Having compared the picture capabilities available by direct television and by direct film processes, we are now in a position to see how each can help the other.

Clearly, it should be possible to televise ordinary motion pictures with negligible quality loss, and there is no doubt that even if this ideal is not at present being attained, it is only a matter of time before the necessary improvements are effected.

Plays in Television

If it is the purpose in a television play to duplicate the art of the theatre, then one can say right away that the film medium is redundant. However, as we all know, the legitimate stage has to confine itself within very definite barriers :—

(*a*) Its number of sets is strictly limited.
(*b*) It can rarely afford sets purely for atmospheric purposes.
(*c*) The sets themselves are limited in size and nature.
(*d*) The tempo of the action is limited by entrances and exits, and the time taken to change costumes.
(*e*) Faking is difficult.
(*f*) An atmosphere of realism is hard to achieve.

Television, being a new medium, is unlikely willingly to submit to these restrictions and it will want to exploit every known technical trick to achieve its effects. In the television play, therefore, we find the film used for :—

(*a*) Atmospheric shots.
(*b*) Exterior action.
(*c*) Special effects, *e.g.*, "the body that falls from the fourth floor window."
(*d*) Continuity sequences which permit change of set.

As to the future, it is likely that the film will be used for back projection (if it has not already been so used) and for trick sequences where the same artist plays two parts simultaneously.

News Items

The next important use of the film in television concerns news items. Clearly one of the great attractions of television is its immediacy. Nevertheless, it is seldom convenient for the mass of viewers to look in at the time when important events take place. The simultaneous shooting of a topical event, both by direct television and with the motion picture camera, is therefore likely to be increasingly carried out.

In doing so, television has two important advantages over the news reel in the kinema. Firstly, of course, it is no longer necessary for a large number of prints to be made, and arrangements effected for their distribution to numerous kinemas. All this takes time and tends to increase the period between the actual event and its appearance on the screen.

Secondly, as far as the television film machine is concerned, it can run negative film, and by switching in a phase reversing unit, can convert the result into a positive picture.

Illustration of Talks

A lesser known use of the film in the television studio is for the illustration of talks. As an example, I was able last year to have made a number of animated diagrams dealing with atomic structure and atomic energy, to be used in the same way as lantern slides for the Faraday Lecture. A month or so ago, the lecturer, Dr. T. E. Allibone, gave a similar talk from Alexandra Palace, using the same film. At a given cue, the lecturer was faded out and replaced by the film, this occurring some ten or twelve times during the talk. The technique proved surprisingly attractive and it relieved the lecturer from the strain of being televised over a considerable period of time.

The Film as a Programme Item

An important part which the film can play in the television studio, is that of a self-contained programme item. Such usage has many attractions, and nothing would please viewers more than to sit at home and let their favourite film-star entertain them. It is inevitable, however, that financial problems must be solved before this is an everyday occurrence, as it is unreasonable to expect film producers who have spent large sums of money on their productions, to hand them over to the television authorities for the comparatively small amount that the latter can afford to pay.

As far as the magazine type of film is concerned, this is of course a much cheaper type of production, and there may in the future be an increasing supply of such films for television.

Apart from representing an attractive programme item, the film also serves as a standby, should for any reason the advertised programme have to be cancelled at the last minute.

As an instance of the use of a film as a complete programme in television must be mentioned the B.B.C.'s Television Demonstration Film. In the present state of television it is not economic to radiate a live programme in the morning. Nevertheless it is apparent that many people visit dealers' shops at this time of day and wish to inspect a television set. As film people know full well, there is nothing more depressing than a blank screen, and it was therefore decided, both in the interests of television progress and of the dealers themselves, to have made a film playing for about an hour, which could be radiated regularly every morning.

The B.B.C. film, " Television is Here Again," was projected.

The future use of films specially prepared for television programmes depends mainly on economics. Where there is a nation-wide system of television stations, and the distances are large, as for example in the U.S.A., it may prove cheaper to distribute programmes in film form rather than incur the very heavy cost of co-axial cables and repeater stations.

Considerable thought has been given to this subject, both in this country and in America[8]. Over here, the Television Service has already prepared a number of interest films on an economic basis. It has achieved this by shooting exact footages to a well-planned script, by dispensing with all positive prints, projecting the negative with the help of a phase reversing unit, and by using a live commentator instead of recorded sound.

Recording the Televised Image

The film is likely to be used in the future for recording television programmes at the same time as they are radiated. This would permit repeat performances from the same station, or performances from more distant provincial stations.

Before this becomes an actuality, however, certain problems have to be solved. Due to the low inertia of television systems, it is possible for successive frames to appear on the screen with only a very small time interval for the picture change.

The ordinary motion picture, however, usually takes about as long to move its film as it allows for the exposure. That is to say, running at the rate of 24 frames per second, and with a shutter opening of 180 degrees, an exposure of 1/48th of a second is given, and a further 1/48th of a second is required, during which the next frame moves into position.

The interlaced television image is displayed at the rate of 50 frames per second. As only ten lines are lost during a frame change, the time interval between successive frames is of the order of one thousandth of a second.

It is, of course, possible now to film the television screen, but due to the limitations already outlined, the recorded picture omits one set of interlacing and thus exposes only 50% of the effective number of lines.

However, it is clearly very important for a television service to be able to record its picture, and it is likely that the problem may be solved in the future.

Such a facility would obviate the necessity for the film unit to be present on location when news items are being televised.

III. TELEVISION AS AN AID TO THE MOTION PICTURE INDUSTRY

So far we have discussed how the film can be of assistance to the television studio. Let us now look at some of the ways in which television may be able to come to the aid of the film industry.

I must, however, warn you that this is necessarily a dream of the future, because the film industry is unlikely to make substantial use of this new medium until the picture quality attainable is at least equal to that given by the ordinary photographic process. Although we are promised 1,000 line television within the next few years, we have still to convince ourselves that in addition to resolution, the television image will have the contrast ratio and fidelity of reproduction which delights the cameraman and satisfies the audience.

Television in the Studio

Nevertheless, if we grant that one day the television picture will equal that of the film, then the picture making side of a studio may tend to resemble in principle that of the sound recording side.

On the floor our present cameras may be replaced by television cameras which transmit the picture to a monitor room where the director can see and hear the action on a screen while rehearsing or taking, and to a picture recording room where the television image is photographed by special motion picture cameras.

Such a set-up is attractive from many angles. On the floor the television camera provides a light, silent camera. Its sensitivity to light will by this time greatly exceed that of the photographic emulsion. It will thus be able to work at lower levels of illumination, and possibly also, by stopping down its lenses, have a greater depth of focus.

In the monitor room, the director will have the advantage of being able to judge this scene as it will finally appear on the screen. He will no longer be misled by the stereoscopic effect of his own eyes, nor will he be uncertain as to what is being cut by the frame line. Also, the contrast of the picture will be to some extent under his control for special dramatic effects. It is possible, too, that many tracking shots will be done by means of an electronic " zoom " which could also be under his control in such a monitor room.

When rehearsals indicate that the scene is ready to be shot, the picture recording room will spring to life. Here special forms of motion picture cameras will operate under dry, dust-free conditions. It is possible that the television image will be so presented, and the camera synchronised, that an intermittent is unnecessary. Standby camera units will be available, so that in the event of one failing another can be switched in. This should also solve the " short end " problem since, as one camera is approaching the end of a roll of film, another can be started up, overlapping the action.

Transmission from the Film Studio

When the film studio is thus equipped, it may also have facilities for passing its television signal direct to a transmitter, thereby permitting kinemas, which by this time will be wired for television, to give a " live " show. It seems unlikely that this will apply to plays for the reasons that we have already given, but variety acts and such like could very well be radiated.

From all this the broad principle seems to emerge which may govern the nature of our entertainment in the future. Plays, whether they be tragedies or comedies, require the canvas and polish of the motion picture film that we know at present. It is unlikely that audiences of the future will be satified with less. Musical items and variety acts are more straight-forward,

and usually arrive at the studio fully rehearsed. It is likely then that this style of entertainment may be directly televised to kinemas.

As far as newsreels are concerned, national events such as the Derby will no doubt be televised to the kinemas while they are in progress. Meanwhile, the picture recording room at the studio will photograph them, so that they will be radiated again to kinemas the same evening.

If these things are to come about, one may well wonder as to the future relationship of the home television set to the public kinema, for by this time the entertainment value of home television should be of a high order.

The Future of the Kinema

But man is a gregarious animal. He likes to share his entertainment with his fellow creatures. The television set at his fireside is grand in one way, but it will never have the glamour of the evening visit to the kinemas.

The psychological aspect of method of payment also plays its part. Television in the home is paid for by the viewer as an annual licence fee. He therefore switches on his set for items which do not particularly interest him, either to get his money's worth or to entertain his neighbours. A visit to the kinema, particularly if one takes the family, means dipping into the pocket, and one is therefore more careful to ensure that the nature of the entertainment is geared to one's own tastes. In consequence one tends to remember a kinema show with affection.

We who live in this cosmopolitan capital hardly realise the esteem in which a well-run suburban or provincial kinema is held by its patrons.

All such factors must be taken into account in endeavouring to forecast the lines along which our entertainment will develop, and my own opinion is that the kinema theatre will continue to exist because it satisfies an important social need of the world at large.

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DISCUSSION

Mr. F. G. Gunn : A point I have found slightly objectionable is that the lighting is so flat that one could see right down the singer's throat. Is that really necessary ?

The Author : I am not qualified to speak on the technical side of lighting. But it is a general principle, when you have got a number of camera set-ups any of which may be switched in, you have to use flat lighting. The problems are otherwise almost insoluble, to have perfect lighting which will satisfy all three cameras.

Mr. C. J. Phillips : One of the chief snags in viewing films other than cartoon films is that the television picture will not hold the amount of contrast available, with the result that you get black-and-white. But when it is entirely acceptable, it is possible that all plays might be filmed before they are televised. It seems to me that to get a polished play production, it might be necessary to go entirely to film as an intermediate stage.

The Author : I tried to make that point

—that when we have a number of stages or the distance between them is great, it may be that we shall go to film.

Mr. J. New : Your suggestion of the future about films being made in the studio by a television camera needs thought, because of Mr. Gunn's point about lighting. Television does seem flat and terribly uninteresting in camera angles.

The Author : When television is put into the film studio, it will be in the hands of film cameramen, who will give results every bit as good as they have been getting via the direct photographic process. There would be no point in using more than one camera at a time, so the cameramen would have full scope.

A Visitor : Is there any great difference in the rendering of colours in monochrome as far as television is concerned, as compared with the panchromatic film ?

The Author : I have raised that point with the B.B.C. engineers, and they tell me that the present-day Emitron is fairly parallel with pan. stock in spectral sensitivity. In the old days they used to take a curve of the spectral sensitivity every few hours, and adjust make-up and lighting to comply with the requirements of that curve, but now it is very much improved.

Mr. F. G. Gunn : On the few occasions I have seen television they have mixed, and to one who has studied film conventions that seems to suggest a lapse of time, or a change to a different location. Is there any difficulty about getting a direct cut from one camera to another ?

The Author : Cutting was introduced into television after the service re-started. It is not always successful—if they miss the cue you get a blank frame coming between the two cameras, which is a little disconcerting.

Mr. Whitworth : The facilities available to the television stations at the moment are not in any relationship to the facilities available to the film industry.

Mr. T. S. Lyndon-Haynes : We who have watched them, realise they are up against tremendous difficulties. They have two stages ; often they are building a set on one stage while another set is being televised.

Mr. Lee : May I offer a word of reassurance about the obsolescence of the 405-line scanning ? The manufacturers are quite determined that any improvement they put out must not make the old sets obsolete ; the programme that is being televised will for many years have to go out on two different frequencies.

Mr. Levy : On the subject of future developments and television in the kinema, is it not conceivable that as the quality of the television picture improves, eventually the film will be transmitted from one central station to a circuit of kinemas ? If so, would not that finish the job in the projection box ?

Mr. I. D. Wratten : That is rather at the back of my mind. There are considerable economic difficulties, in the cost of laying land lines.

Mr. H. L. Bohm : I suggested to the B.B.C. before the war that 16 mm. film could be used for direct transmission. Is it not true that a tremendous amount of money could be saved by using 16 mm. film if the quality were satisfactory ?

The Author : The matter is purely one of economics—there is no technical reason why one should not scan a 16 mm. picture. But at the moment there is a vast library of material in 35 mm., which does not exist in 16 mm., and I think that probably influenced the B.B.C. in deciding on 35 mm.

Mr. R. H. Cricks : Might it not have been a factor that the 35 mm. Mechau continuous projectors were available ?

The Author : Yes ; no doubt that was a factor.

A MEMBER FROM JAVA

Mr. The Teng Hoei, a cameraman from Batavia, has been paying a visit of survey of the film industry of this country, and desires, through the medium of *British Kinematography*, to express his appreciation to those various members with whom he has been in contact, and who have given him assistance.

Among the members he especially wishes to mention are the following : R. H. Bomback (Pathé), C. Cattermoul, A. Challinor (G.B.-Kalee), G. J. Craig (Kodak), C. A. Evemy (Warner Bros.), D. Forrester (Films & Equipments), W. Harcourt (Denham Laboratories), Rex B. Hartley and Dr. F. S. Hawkins (G.E.C.), B. Honri (Ealing Studios), L. Knopp (C.E.A.), C. F. Parkins (Studio Film Laboratories), P. Sunderland (British Movietonews), A. A. Waters (United Motion Pictures), L. T. White (George Humphries), and I. D. Wratten (Kodak).

Mr. The's studio in Batavia, in which full-length features were produced, was burnt out by the Japanese, and all his equipment removed. He has now left for Paris, Brussels and Amsterdam, and is shortly flying back to Batavia.

RECENT DEVELOPMENTS IN CARBON ARC LAMPS

C. G. Heys Hallett, M.A., A.I.P.E., M.B.K.S.*

Read to the British Kinematograph Society on May 14, 1947, and to the Newcastle-on-Tyne Section on October 7, 1947

THE object of this paper is a consideration of the potentialities of the illuminating arc. It must first be made quite clear that we are investigating the increase in light output which can be expected, without giving any consideration to whether it would be worth the trouble or be of any practical or commercial use.

I. THE MASTER CURVE

Fig. 1 shows the relation between current and peak brightness for a typical high-intensity arc. It will be noted that, though the rate of increase diminishes, the light continues to increase with the current. At higher currents the arc becomes very unstable and noisy and it is this factor which sets the limit to the current at which it can be used.

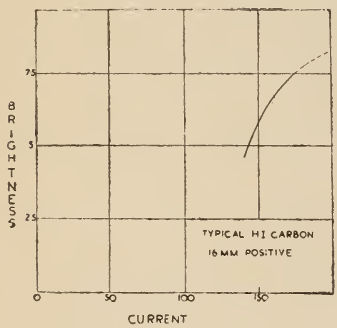

Fig. 1. Relation between Current and Crater Brightness for a typical H.I. Carbon.

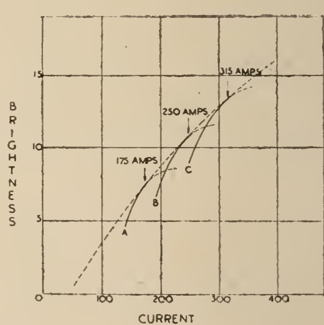

Fig. 2. Characteristic Curves for set of three H.I. Positives designed to run at different Currents. Tangent point to common Tangent shows Current of maximum efficiency for each Carbon.

It is possible to design a carbon which will run satisfactorily at higher currents and Fig. 2 shows the characteristics of a group of three carbons, all of the same diameter and designed as a series to run at three different currents. It will be seen that the curves cross one another owing to the variation of efficiency with current. The curve A is for a carbon in common use, Carbon B can be used in a few lamps, but Carbon C is beyond the capacity of all except the lamp which will be described later.

All these characteristic curves are tangents to the curve which is shown dotted, and which may be called the Master Curve. The points at which these characteristic curves touch this Master Curve indicate the currents of maximum efficiency for each type of carbon. It can, therefore, be used to predict the potentialities of any particular intermediate carbon yet to be designed.

Before proceeding to the next stage, it is convenient to convert the scale from current to current density by dividing by the cross sectional area (Fig. 3).

* Morgan Crucible Co., Ltd.

Extrapolation of Curve

The question arises as to whether this Master Curve represents the limit of light output for a given current. I believe this curve to be very close indeed to the maximum. Many carbons are in existence which fail to reach this Master Curve, but I have seen no evidence that any carbon has crossed it. Unless some revolutionary discovery is made, similar to that which preceded the change from low- to high-intensity carbons, it appears to represent the limit of possibility.

For the present the possibilities of climbing along the curve have to be studied, and the question of crossing it left to the future.

Fig. 3 shows the range over which this Master Curve has so far been explored. The characteristic curves of the three carbons shown in Fig. 2 are shown for comparison. It will be seen that the curve is still rising at the limit plotted, and no evidence has yet been found to indicate that considerable extrapolation is not possible.

II. CARBON CONTACTS

Climbing up the Master Curve involves considerable increase in current density, which is already very close to the limit of the lamp mechanisms

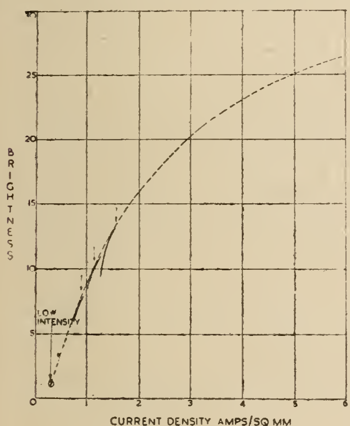

Fig. 3. The full Range over which the Master Curve has been explored. Arrows indicate Tangent Points of Carbons A, B, and C for Fig. 2.

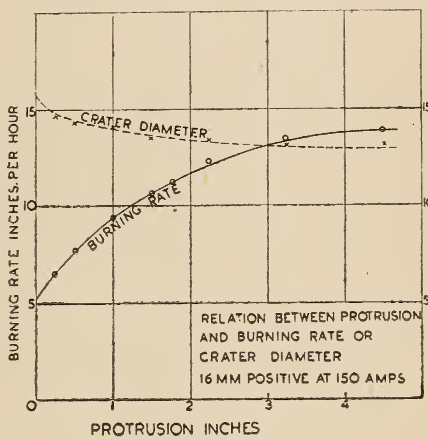

Fig. 4. Variation of Burning Rate and Crater Diameter with Protrusion of 16 mm. H.I. Positive at 150 amps.

available and also to that of the copper coating on the carbon. Consequently, the first major problem encountered is the development of a contact system which will enable uncoppered carbons to be handled without trouble at currents several times those normally employed.

The requirements of the contact system cover a wider field than is at first appreciated.

Carbon Protrusion

The protrusion of the positive carbon is a point of major importance. because it is intimately connected with the burning rate of the carbon, Research with extremely small protrusions has shown that a considerable reduction of burning rate without loss of light can be obtained by this means.

The magnitude of this economy is shown in Fig. 4, from which it will be seen that well designed contacts enable the burning rate to be reduced to half that normally obtained.

Current Transmission

The electrical resistance of the shell of the carbon is considerable, and the temperature gradient which it can withstand without cracking is strictly limited ; if the current is not evenly distributed round the circumference of the carbon, if it tends to flow in streaks, the gradient may be sufficient to cause longitudinal splitting of the shell. This is particularly liable to occur in the gaps between contacts. Uneven distribution of current will also have an effect in the crater, and will cause it to burn away faster on one side than the other.

If sparking is allowed to occur at the contact faces the point at which current flows into the carbon will be liable to frequent and sudden changes in position, which will have a serious effect on the steadiness of the arc. The conveyance of the current into the contacts is a point requiring careful consideration, because, at the current densities involved, asbestos insulated copper flexibles, which give enough trouble at normal currents, fail entirely.

Mechanical and Thermal Problems

The mechanical properties of the contact system are also of great importance. Both positive and negative carbons must be located with a high degree of accuracy ; the resistance to motion provided by the contacts must not be excessive ; contacts should be easy to dismount for cleaning, preferably without disturbing any connections ; replacement should be simple and not costly.

If any springs are used to apply the contact pressure, they must be effectively shielded from heat, both radiant and conducted.

The thermal problems are, perhaps, the most important. The contacts must be capable of extracting large amounts of heat from the carbon and disposing of it without detriment to themselves. Some heat will be generated in the contacts, hence they must be able to dispose of more heat than they receive from the carbon.

Requirements of Contacts

The requirements may, therefore, be summarised as follows :—

1. Capable of working with short carbon protrusion.
2. Capable of carrying a heavy current and distributing it uniformly round the carbon.
3. Able to extract and dispose of large amounts of heat.
4. Reliable connections to main conductors.
5. Accurate location.
6. Low friction.
7. Simplicity and ease of dismantling.

None of the usual forms of contact holds any promise of being capable of modification to meet these needs.

The ability to dispose of large amounts of heat disqualifies all types in which the junction between the contact and mechanism is inferior to that between contact and carbon. The employment of alloys capable of withstanding high temperatures makes the situation worse instead of better, because their high electrical resistance and low thermal conductivity increase the amount of heat.

It was decided that the ultimate disposal of the heat must be to water. The provision of a water supply is not, in practice, an inconvenience, because the projector, which has to handle the greatly increased amount of light, also needs this medium, and a simple but efficient self-contained cooling system is silent in operation and less costly than alternative methods.

Form of Contact Jaws

Intimacy of contact between the contacts and the jacket can only be

obtained by a wedge form, but care must be taken to prevent the wedges becoming self-jamming as the carbon is fed forward. The angle required is large—57°—and a single wedge of this shape would be very unstable andt he diameter of the jacket would be excessive ; it would also be exceedingly difficult to machine.

The wedge could be rectangular, the back serrated so as to provide a series of wedges, but this would make manufacture almost impossible. Serrated circular contacts would be easy to make, but the width of the slots between the segments would have to be so great in order to allow them to be inserted and removed, that the distribution of current round the carbon would not be adequate. This serious defect can, however, be overcome by making the serrations in the form of a helix or, in other words, a screw thread, so that the segments of the jaw can be screwed in and out ; the width of the gaps can then be reduced to that given by the thinnest practicable saw.

The helix thus assumes a form resembling a buttress thread. This circular or helical form has an apparent defect which, in practice, is found to be quite unimportant ; in the circular form the mating surfaces become conical and can, therefore, be in perfect contact only when the carbon diameter is exactly correct. That this consideration is not important in practice has been demonstrated.

Carbon Surface

The carbon, however, must also contribute its share to the solution of the problem. Its surface must be perfectly regular and smooth, because any irregularity will cause local concentration of current which will not only destroy the surface of the contact, but will also affect the distribution of current and, therefore, the crater formation, and may also cause the shell to crack.

In practice, this involves centreless grinding of the carbons—a simple and efficient process, which produces carbons to a high degree of accuracy well within the tolerance of the contacts.

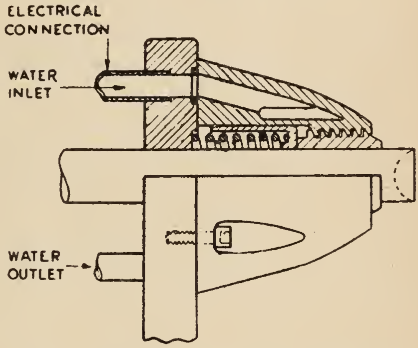

Fig. 5. Part Sectional Diagram of Morganite H.D. Contact.

Positive Head

Fig. 5 shows a sectional elevation of the contact assembly. The serrated jaws are $\frac{3}{4}$ in. long for currents up to about 300 amps. and $1\frac{1}{4}$ in. up to 1200 amps. The diameter of the buttress thread is $\frac{7}{8}$ in. for carbons up to 11 mm. diameter. These jaws are urged against the wedge faces by means of a spring and spring cup which, being enclosed within the water jacket, remain quite cold.

The contact head is bolted to the mechanism by three bolts. Ports in the head register with water ports in the mechanism, and are rendered watertight by rubber rings, while the current is conveyed across the surface against which the head is bolted. The water is conveyed from the terminal blocks to the contact heads by copper pipes $\frac{1}{4}$ in. diameter, which also fulfil the very important duty of conveying the current, thus providing conductors which are entirely free from trouble.

Fig. 6 shows the heads installed in a lamp and with burnt carbons in position. The run of the waterpipes, which also convey the current, can be clearly seen. The whole of the flat casting to which the positive head is bolted is water cooled to act as a radiation shield to keep the heat away from the mechanism.

Fig. 6. Morganite H.D. Contacts as mounted in Mole-Richardson Type M.R. 1250 Lamp.

Fig. 7. Showing Method of dismountin[g] Jaws in Mole-Richardson Type M.R. 125[0] Lamp. Positive Jaws removed and re[-]tained in Tool. Negative jaws partl[y] extracted.

Water Circulation

Fig. 7 shows the positive jaws entirely removed and the key inserted in the negative jaws which are partly unscrewed. This illustrates the method by which the only renewable part of the contact system is removed and replaced without disturbing any connections, either electrical or water.

It is customary to pass the water through the positive and negative contact heads in series. Copper pipes are used to convey the current from the terminal blocks to the heads, and about a foot or so of rubber hose is used to convey the water from the positive head to the negative. The heat carried away in the water from both positive and negative contact heads, and also from the heat shield, represents less than 20% of the arc watts, and can readily be handled by a water flow of 2 to 3 pints per minute. The extreme limits of these contact heads have not yet been determined, but the heads have been successfully employed at current densities up to 10 amps. per sq. mm.

Life of Jaws

It is too early to make definite statements as to the life of these contacts, but it may be said that no head has yet had to be replaced in this or any other lamp, and the failure of jaws is entirely due to deterioration of the surface in contact with the carbon ; no case of deterioration of the screw thread has yet been observed. It can be definitely stated that the cost of replacement jaws is unlikely to exceed $2\frac{1}{2}$% of the cost of the carbons burned, which is very small compared with the reduction in burning rate of the carbons which, as shown in Fig. 4, may be of the order of 50%.

Some of the test carbons from which the curve of Fig. 4 was derived, are shown in Fig. 8. The clean cut contact line is clearly visible.

III. CARBON CONTROL

We will now turn to the problems connected with the control of high power arcs. That the relatively simple methods, which have sufficed in the past, will not do so in the future is illustrated by Fig. 9, which shows the relation between burning rate and time for a normal arc. It will be seen that the burning rate varies continuously from the moment of striking the arc until it has been burning for 18 minutes.

Burning Rate

It is customary to measure the length of carbon burned in a given time, to use that value to calculate the amount which would be burned in one hour,

and to call that the burning rate. The curve shows the importance of the time over which the test is taken. During the first 10 minutes, the average rate is 4.9 in. per hour, as compared with the steady rate of 9.3 in. per hour from the 18th minute onwards.

The curve for a negative carbon is shown on the right of Fig. 9, and it will be seen that its curvature is in the opposite sense to that of the positive.

Control Requirements

The ratio of the burning rates of the positive and negative carbons starts at 1 : 1, and exceeds 3 : 1 after 20 minutes, so it is apparent that a single feed motor with a fixed gear ratio is not sufficiently accurate for heavy duty arcs.

The requirements of the control system for high power arcs can be derived from a study of first principles. An arc lamp can only give correct performance if the following requirements are met :

1. The light source (the positive crater) must be maintained at the focal point of the optical system.
2. The negative carbon must be controlled so that the arc voltage is maintained at the correct value.

Positive Feed Control

The positive feed must be automatically regulated so as to maintain the crater in a fixed position with an accuracy dependent on the focal length of the optical system. In modern arcs it may be stated that a movement of 0.1 mm. either side of the mean is the maximum which should be tolerated.

Fig. 8. Illustration of undamaged Die Skin of Carbon. Photograph of some Carbons used for Protrusion Tests for Fig. 6 showing Formation. Note clear cut Line marking position of end of Jaws and undamaged Die Skin on Carbons.

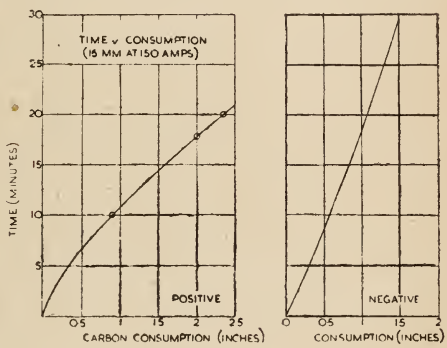

Fig. 9. Relation between Carbon Consumption and Time for unused 16mm. Positive and 11 mm. Negative at 150 amps. showing change of Burning Rate during early stages.

In practice, therefore, a device is required which will accelerate or retard the positive feed according to the position of the crater. This can, of course, be achieved by means of a photo-electric cell, but the circuit and optical arrangements are complicated and very expensive.

The Automatic Focus Control shown in Fig. 10 was developed to fill the need for a simple but effective instrument. It will be seen that it consists of two bi-metal strips ; one strip, which carries the moving contact, is mounted on the free end of the other. A small magnet is fitted to provide a quick make-and-break.

A rise in ambient temperature will affect both strips equally ; the instrument is, in fact, insensitive to changes in ambient temperature up to 80° C. The instrument functions solely on the difference in temperature of the two strips. An image of the arc is thrown on to these strips by means of a lens made of a type of glass which also passes infra-red radiation.

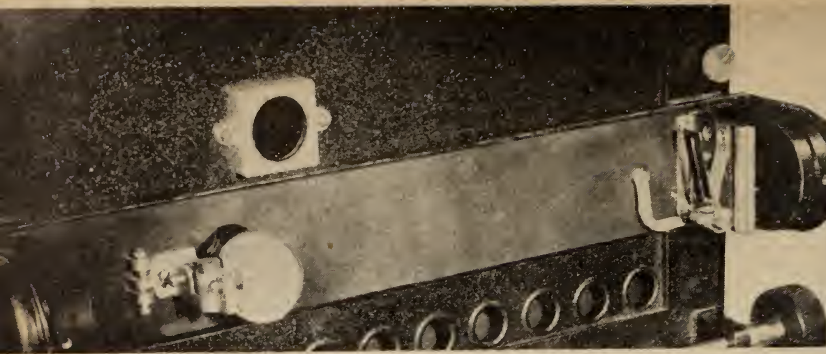

Fig. 10. Morg… Auto Focus Co… mounted on M… Richardson … 1250 Lamp.

Operation of Thermostat

Fig. 11 shows the distribution of radiant energy, as measured with a thermopile, along the longitudinal axis of the arc. It will be seen that there is a marked peak immediately in front of the crater, and it is this peak which is utilised to cause the carbon to move until the temperature of the two strips is equal, which will be in the position shown in the left hand diagram to Fig. 12.

If the image is moved so that the peak of the curve lies between the two strips, as in the right hand diagram, strip A will receive more heat than strip B, and the contacts will be firmly made. But if the gap adjustment is moved until the contacts just break, this excess of heat on strip A will be compensated for, the sensitivity will be greatly increased, and the instrument will continue to maintain the carbon in this position.

The size of the arc image may be regulated by varying the focal length of the lens ; normally, the gap width is adjusted for use with a magnification of about $2\frac{1}{2}$, and when thus installed, the instrument can maintain the crater with an accuracy of ± 0.10 mm.

Negative Feed Control of Mole-Richardson Type M.R. 1250 Lamp

The negative feed is provided with a separate motor which is controlled by a bridge circuit in which the arc and the ballast resistance form two legs. The negative feed motor operates so as to balance the arc voltage against the volt drop in part of the ballast resistance. With constant current, the arc voltage will, therefore, be maintained constant, but should the current fall the feed will shorten the arc until the arc voltage is correct for that current.

As the motor is connected in a bridge circuit it will, of course, run in either direction, according to whether the arc is too short or too long. This feature obviously provides automatic striking as well, because when the switch is

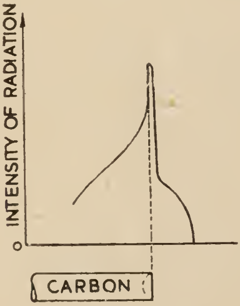

Fig. 11. Distribution of Radiant Energy along Axis of Positive Carbon in a typical High-Intensity Arc.

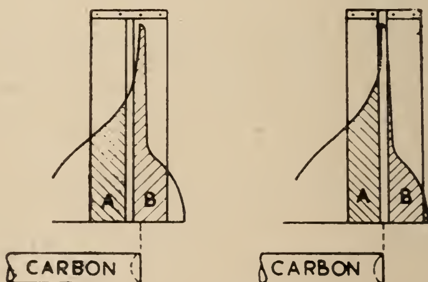

Fig. 12. Position in which Crater is retained by Morganite Auto Focus Control (left) *when Contacts are adjusted cold and* (right) *correctly adjusted when Lamp is burning.*

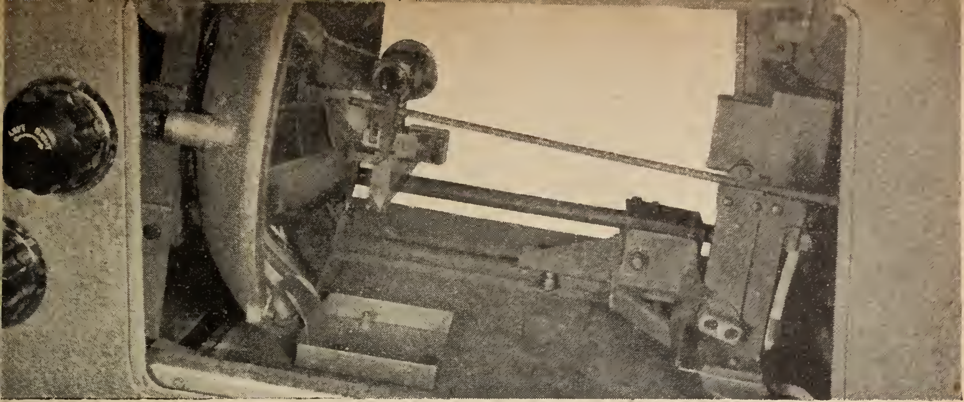

Fig. 13. Focus Control fitted to B.T.-H. Types H. and K. and SUPA Arc Lamps.

made, the motor will close the arc at full speed until the carbons touch, and when current starts to flow the arc voltage will be far too low and the feed motor will automatically reverse until the arc has been opened out to correct length. The same negative carbon, 11 mm. diameter, is used at all currents.

Two new arc lamps employ this automatic focus control. Fig. 10 shows the instrument mounted on the door of the Mole-Richardson type M.R. 1250, while Fig. 13 shows the method of mounting employed in the B.T.H. lamps. The lens and mirror are mounted on the far side of the bracket carrying the front guide for the positive carbon, while the instrument itself is housed in the casting fixed inside the lamphouse just to the right of the door.

Mechanical Details of Feed

The MR 1250 lamp employs their well-known carbon feed system, comprising a scroll plate driving feed wheels mounted in a carriage. The scroll plate and feed wheel carriage are driven by two separate motors, and the feed rate depends on the difference between their speeds, and, thus, can be adjusted over a very wide range, from zero upwards.

A tapped resistance is put in series with the armature of the motor which drives the scroll plate. Each of the three tappings is connected to a three-position selector switch, which also controls the circuits of the contactors in the ballast resistance. The tappings are adjusted to give motor speeds slightly below the burning rate of the three carbons. Part of this resistance is shorted by the automatic focus control so as to accelerate the motor to slightly more than the burning rate.

The motor which controls the rotation runs at approximately the same speed at all currents, and is fitted with a variable resistance so that its speed can be regulated as a fine adjustment for the carbon feed rate. The three carbons in question have a maximum burning rate of approximately 40 inches per hour, but by changing the tapping of the resistances the lamp can be made to feed at any speed between zero and well over 100 inches per hour.

All that has to be done to alter the current is to change the positive carbon, move the selector switch to a new position and make the contactor switch. The arc will then strike automatically and maintain itself with accuracy.

(*By courtesy of Mole-Richardson* (*England*), *Ltd., their Type M.R.* 1250 *lamp, embodying the above described developments, was demonstrated.*)

IV. PERFORMANCE OF ARC

The performance of this arc lamp is well illustrated by the charts obtained with a specially developed recorder. Charts taken with the MR. 250 lamp are shown in Fig. 14.

The black trace is made by an Einthoven galvanometer recording the light, while the three white traces recording current, arc volts and line volts

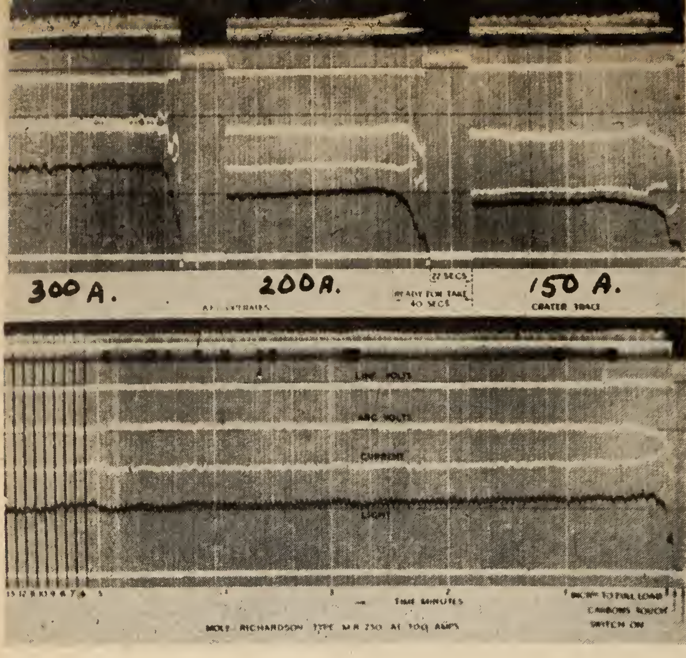

Fig. 14. Two charts illust Performance of Mole-Richa type M.R. 1250. Showing, relative Performance at Currents and Time to c Carbons and Current. B Constancy of Light Outpu Crater of Positive durin automatic Run of 13 minu

respectively, were made by d'Arsonval type galvanometers. A fourth galvanometer, which was not in use, remained at zero. The vertical white lines are timing marks at 10 second intervals, starting automatically on the completion of the arc circuit. The black patches at the upper part of the chart are made by a relay in parallel with the automatic focus control, and record the periods during which its contacts were made and broken.

The trace at the top of each chart records the crater in the following manner. A lens throws an image of the crater on to a cylindrical lens and thence on to the film which is wrapped round a drum, whose axis is parallel to the axis of the positive carbon. The film, therefore, gives a continuous record of the exact position of the end of the carbon nearest to the lens system. A magnification of 3 to 1 is employed, so that the accuracy of the automatic focus control can be measured with precision.

Record of Performance

This trace also gives a very searching record of the performance and crater formation of the carbon. If the crater has a perfectly even edge, normal to the axis of the carbon, the trace will be a straight line. If the edge of the crater is plane but at an angle to the axis, the resultant trace will, with a rotating carbon, be sinusoidal, and any deviation from this form will be an indication that the crater edge is imperfect.

The lower chart shows the behaviour during automatic striking, and indicates that shooting could safely commence within 20 seconds of striking. After 5 minutes the camera commenced to run intermittently and to record 5 second periods at 1 minute intervals and shows that the lamp continued to run automatically with a high degree of steadiness.

Rapid Re-trimming

The upper chart shows the performance whilst all three of the carbons, illustrated in Fig. 2, were burned in succession. The camera ran continuously and the chart shows that the time taken to change the positive and restrike was 22 seconds, which may be regarded as normal. When trimming the lamp, the positive carbons were positioned by eye only, and the chart shows that, in the second test, the carbon was placed 2 mm. short of the correct position. This was sufficient to affect the light adversely, but the automatic focus control operated after 11 seconds and had corrected the position of the crater within 28 seconds of the arc being struck. In the third test, the carbon

was placed 1 mm. too far forward, but the high burning rate at the moment of striking soon corrected this.

As the optical system is specified by the customer and is not part of the lamp, it is not possible to state a value for the light output, but reference to Fig. 2 will show that, as a light source, this fully automatic arc can safely claim to be the most powerful standard model available to the industry.

DISCUSSION

Mr. F. G. Gunn : Is this an English Mole-Richardson development ?

The Author : Definitely. It is based on the design of a lamp which has been in use in Hollywood for a fair amount of time. But in Hollywood the maximum is 220 amps. It has been modified by the water-cooled contacts and the automatic focus control, which are developments added by Mole-Richardson (England), Ltd.

Mr. W. Bland : In view of the fact that you got with other carbons curves that fell below the Master Curve, do you take it that you have reached the ultimate in carbons—that no other carbon in future can go above that curve ?

The Author : That is my personal belief. That curve is based on the highest light measurements taken, either in my own laboratory or in published literature anywhere. To the best of my belief it has never been passed, and many of the smaller carbons do not reach the curve, possiblyadue to their having a greater surface are in relation to cross-sectional area.

Mr. R. H. Cricks : I noticed that the curves of brightness, if they had been logarithmic, would have been straight lines ; has that any significance ? To what do you attribute the curvature of the burning rate curves with time ?

The Author : It is entirely due to the formation of the carbon. I did a series of tests on the shape of the tip of a negative carbon, and found that under normal conditions, there was no such thing as a final shape of the negative tip. It started off by being bulbous, and then tended to spindle to concave lines, and then returned to convex lines. Although the swing of the pendulum became less after 1½ hours, the carbon had not made up its mind. The positive carbon was, of course, a new carbon, with no crater, and the carbon had to excavate its own crater, and then the outside walls of the crater had to taper down to reduce the size of the carbon to its final diameter. It is those changes in the shape of the carbons which cause the burning rate to vary.

Mr. F. G. Gunn : Do you think the brightnesses attained by these arrangements are likely to be exceeded by other forms of illuminant, such as H.P. mercury ?

The Author : I should regard it as impossible for any discharge enclosed in a transparent envelope to exceed what can be done with a free arc in open air. I say that in quite an academic sense, because we all know that the incandescent lamp displaced the arc, not on the grounds of economy, but of convenience.

Mr. F. G. Gunn : I am not sure I understood your remark regarding the peaky curve in connection with the carbon control. Is that the actual distribution of heat around the crater ?

The Author : I can answer you best by telling you how the curve was obtained. We put a spectacle lens about 18 ins. from the arc, and we put a thermopile at a considerable distance. We slid the thermopile through the image of the arc, and plotted the galvanometer readings. It is a distribution of energy on the centre line of the carbon through the arc.

PURCHASE TAX ON PROJECTOR LAMPS

It is the decision of H.M. Customs and Excise that purchase tax on projection lamps shall now be the same as for other lamps with tungsten filaments, *i.e.*, taxable up to, and including 250 watts, instead of up to and including 750 watts.

The rate of purchase tax on tungsten filament lamps was increased under the recent special Budget from 33 1/3rd to 50% of the wholesale value. The current rate of purchase tax, where applicable, on projector lamps is therefore chargeable to the trade at 39% of the list price.

PROBLEMS OF 16mm. PRODUCTION

Summary of Papers read to the B.K.S. Sub-Standard Film Division on November 27th, 1947

COLOUR PROBLEMS

J. P. J. Chapman, M.B.K.S., A.R.P.S.

MR. CHAPMAN spoke of the difficulties he had encountered when using regular Kodachrome. The reflection of light from water and highly polished surfaces caused false colour rendering, and in certain cases, particularly when using telephoto lenses, a fogged effect, due to U.V. scatter in the lenses. It might be said that haze filters could be employed, but Mr. Chapman's experience was that this appeared to upset the richness of the colours and produced other out-of-balance effects. These troubles did not occur between latitude 32° North and 32° South (depending on local conditions), and it was possible to avoid them by employing Kodachrome Type A film which in daylight, with the appropriate filter, gave truer and richer colour rendering.

Mr. Chapman recommended employing Kodachrome Type A exclusively, for both exterior and interior work, and referred to the use of booster light sources with appropriate filters. He described a method of matching, consisting of placing a colour card in a box, half of which was illuminated by daylight, the other half being lit by filtered tungsten light. A resistance was incorporated in the circuit to enable the colour temperature of the tungsten light to be raised or lowered until a reasonable visible colour match was obtained. Many effects could be produced by the use of filters, both on the camera and in combination with lights. When filters other than the standard type A filter were used on the camera, re-determination of the exposure could be made by taking a reading through the filter.

Mr. Chapman referred to the problem of duplicating Kodachrome and hoped that the principles of the new Kodacolor process would be adopted to kine. film in due course.

PROBLEMS OF EXPOSURE DETERMINATION

Stanley Schofield, M.B.K.S., F.R.P.S., F.R.S.A.

Mr. Schofield reviewed various methods available for determining exposure, dealing particularly with the failings of each method, problems of mixed lighting and subjects having a tone range greater than that which can be recorded.

There were dangers in following too closely the readings of an ordinary exposure meter and judgment had to be exercised in interpreting the results. For example, a black suit could easily be rendered grey if direct exposure meter readings were followed blindly. A white object in such circumstances would also be rendered grey.

When working in colour Mr. Schofield had found that exposure limits were narrow and restricted to plus or minus half a stop if a fair rendering was to be obtained. Allowance had to be made if the stock was more than six months old, but he had made use of Kodachrome that was considerably out-dated by up to four or five years and found it still usable by making an allowance of only one stop. For colour work, Mr. Schofield recommended the use of a highlight meter such as the Smethurst. This was ideal for measuring front and top lighting. The desirability of modelling should not be overlooked and to secure good modelling effects, side and back lighting were important.

Problems of lighting arose when shooting in large areas such as were encountered in factories, and portable backgrounds were a big asset in such cases. When such backgrounds were used a Weston type of meter could be successfully employed.

PROCESSING PROBLEMS

Hubert Davey, M.B.K.S.

Mr. Davey pointed out that any film unit producing directly on 16 mm. had the choice of two systems, namely, reversal and negative-positive. He did not wish to enter into the pros and cons of these, but had the following points to make.

As far as reversal was concerned, he found that even in black-and-white, processing varied to a considerable extent ; one set of results might be reasonably clean and bright and the next flat and dirty. It was desirable in black-and-white and essential in colour to send the whole of the exposed film to be processed in the same bath, but this led to the difficulty that the director was unable to see his rushes until after the whole film was photographed. Considerable delay to production occurred as a result of this, but there was also further delay due to the time taken at the processing station. Quality had deteriorated since the war and he wanted a return to pre-war standards of cleanliness and quality.

In negative-positive working, one might obtain good negatives, but the positives were frequently poor, with bad grading and excessive grain. Again, he had experienced delays and wished to see a marked improvement in laboratory services. He summed up by stating that what was required was a service for 16 mm. professionals that would process reversal or negative film to 35 mm. technical standards with something approaching 35 mm. speed, which would print reversal or negative film equally well and quickly and which would print master copies with optical effects and make married prints. Finally he entered a plea that the 16 mm. producer should not be treated as an amateur.

EDITING PROBLEMS

Denis Ward, Ph.D., M.B.K.S.*

Dr. Ward referred to the lack of equipment available for the 16 mm. editor. Although 16 mm. film was now definitely being used for professional production, we were in a transitional phase during which 16 mm. equipment and facilities were neither wholly amateur nor yet fully professional. All the facilities to be found in 35 mm. editing were needed in the 16 mm. cutting room, but not necessarily reduced in size from 35 mm. equipment in the ratio of 16/35.

A 16 mm. editing machine of Moviola type had been made, and he wanted such a machine readily available giving a reasonably sized picture with forward and reverse motion, rapid start and stop, which could be hand-turned as well as run at the standard speed of 24 frames per second, and which, further, should be quiet in operation, and with a picture and sound linked firmly together. He wanted good firmly made rewinds with standard shafts, and instanced how some winders will take all makes of reel and some will not. He referred to the need for standardisation of reels as regards size, centre cores and holes, and mentioned that the B.K.S. had recommendations in hand.

Dr. Ward wanted to see improved splicers available which would make a narrow, dry, straight splice easily. Many were quite unsuitable, especially

* Times Film Co., Ltd.

those which were copies of 35 mm. splicers. He wished to see a film cement that would really stick firmly, especially for use with Kodachrome film, and would like to see this marketed and not have to make it up himself. He particularly wished to see the edge numbering of film introduced, and did not wish to do this himself. He wanted optical printing of good quality for use with colour, and if this meant special emulsions, they should be provided. He looked forward eagerly to the day when the manufacturers would cater for the 16 mm. user in a fully professional fashion.

DISCUSSION

Mr. B. Honri : If one of these gentlemen were commissioned to produce a film, to be shot on 16 mm., say of an open-air subject, could we have some idea of the comparative costs of the two methods, reversal and negative/positive, or taking on 35 mm. and reducing to 16 mm., and also a comparison as to whether the sound would be taken on 35 mm. or direct on 16 mm.

Mr. H. Davey : It is very largely a question of budget. If you are on a proposition which can stand the expense, there is a gain in photographing on 35 mm. and reducing to 16 mm. But again it is dependent upon the laboratory services. Roughly speaking, stock costs five times as much to shoot in 35 mm. as in 16 mm. If you have not got a 35 mm. cameraman you can probably hire one complete with camera from £25 to £30 a week upwards. Lighting will probably cost considerably more. I do not like to commit myself on the relative advantages of recording in 35 mm. as direct recording is vastly improved upon against direct 16 mm. recording ; 16 mm. a year or two ago.

Dr. Ward : Without wishing to appear to promote disunity, I do not quite share Mr. Davey's gloom about the laboratories. I am convinced that if one wants a picture for 16 mm. distribution, one should produce in 16 mm. My company, backed by a chain of 35 mm. theatres, could well have decided to use 35 mm., but the type of film we knew we were going to have to make was 16 mm., and with our eyes open we decided to produce in 16 mm. There is a colossal gain in the cost of colour. As for sound, my own opinion is that it is better to use direct 16 mm. sound for direct 16 mm. productions.

Mr. H. S. Hind : The manufacturers have advised us not to go into colour yet, so that if we do and get into trouble, we should blame ourselves, not the manufacturers.

Mr. J. Hadland : We have heard that 16 mm. production is inclined to be unreliable. Is it not a fact that in America, certain productions are photographed in 16 mm. Monopak—I do not know whether it is Kodachrome or Kodacolor.

Mr. I. D. Wratten : A number of pictures have been "blown-up" to 35 mm. Technicolor from 16 mm. Kodachrome, and while the quality level is inevitably inferior to 35 mm. Technicolor prints from subjects produced by the 35 mm. three-strip film camera method, remarkably good results have been obtained.

On the general subject of 16 mm. Kodachrome, you will appreciate that Kodak, Ltd., does not recommend its use at the present time for commercial production in this country. Both the film and the colour processing are in the initial stages of development, and we have a considerable amount of leeway to make up before we can offer similar facilities to those which exist in the U.S.A. We are, of course, aware of the commercial users' requirements, and within the restricted limitations imposed by the aftermath of war, we are doing our best to meet some of these requirements. The position, especially with regard to the availability of 16 mm. Kodachrome raw stock in sufficient quantities and facilities for a rapi duplicating service, is not likely to improv with great rapidity, however.

Mr. J. P. Chapman : As a user solely of colour, I am fully satisfied with Kodachrome. I recently shot 750 ft. in Switzerland, using Rochester and Harrow stock ; I am fully confident of the processing. When those two lots of film came back, it was impossible to tell which was Rochester and which was Harrow. Provided it is kept at a constant temperature I have never had trouble, but you must be careful to thaw it out slowly, otherwise you will get static.

Mr. N. Leevers : One important contributory factor is the human element. We all know the laboratories, half-way through the war, lost many skilled men.

Mr. R. H. Cricks : May I ask Mr. Davey and others who have grumbled about 16 mm. processing whether they have tackled the matter scientifically ; for instance, by putting gamma strips on their negatives, and using them ?

Mr. Davey : I must confess I have not thought of doing so.

TECHNICAL ABSTRACTS

Most of the periodicals here abstracted may be seen in the Society's Library

ALUMINIUM AND CHROMIUM AS GELATINE HARDENERS.
H. L. Baumbach and H. E. Gausman, *J. Soc. Mot. Pic. Eng.*, July, 1946, p. 22.

The chemistry of the hardening of gelatine by aluminium and chromium is discussed in some detail, together with the effects of other probable fixing bath ingredients. The practical consequences of desirable fixing bath formulae and control procedure are assessed, and in particular, the chromium bath is shown to have advantages in rendering washing more complete, though requiring greater care in operation. M. V. H.

LIGHTING AND EXPOSURE CONTROL IN COLOR KINEMATOGRAPHY.
Ralph A. Woolsey, *J. Soc. Mot. Pic. Eng.*, June, 1947, p. 548.

The author describes an exposure meter and calculator of the familiar photc-electric type, whose novelty consists in the provision of three interchangeable light collectors, a hemisphere of diffusing material used to determine exposure, a flat diffusing disc used to measure incident light, and a mask pierced with holes used to measure reflected light. A detailed example is given of the method of use of the device in lighting a set within close limits, showing the purpose of the scales. M. V. H.

THE SOUND SPECTROGRAPH.
W. Koenig, H. V. Dunn and L. Y. Ray, *Jour. Acous. Soc. Amer.*, July, 1946.

The sound spectrograph is a wave analyser which produces a permanent visual record showing the distribution of energy in both frequency and time. One model is described and some of the problems encountered in the design discussed. Examples of sound spectra are included. (Based on *Bell System Technical Journal* abstract.) M. V. H.

A HIGH-QUALITY RECORDING POWER AMPLIFIER.
Kurt Singer, *J. Soc. Mot. Pic. Eng.*, June, 1947, p. 560.

Designed to fulfil modern requirements in film recording, disc recording and monitoring work, this RCA amplifier employs push-pull throughout and substantial negative feedback. Detailed figures on performance are given and a new type mounting for use in relay racks is described. N. L.

ELECTRONIC FIRE AND GAS LIGHT EFFECT.
E. Nye, *J. Soc. Mot. Pic. Eng.*, April, 1947, p. 353.

A small gas flame is used as a primary source of flicker, the light falling on a photocell, which is connected to the control electrode of a thyratron relay valve. This controls the A.C. supply to one or more small projector bulbs, producing a brighter replica of the original flicker which may be used in light fittings or fire-places on a studio set. N. L.

SCREEN ILLUMINATION MEASURING DATA.
Inter Projectionist, July, 1947, p. 5.

It is considered that for the assessment of screen illumination, it is sufficient to take five foot-candle readings, respectively top left, centre of left and right edges, bottom right, and centre. R. H. C.

DETERMINING THE SHAPE OF THE IMAGE SURFACE IN 16MM. PROJECTION.
F. H. Kolb, A. C. Robertson, and R. H. Talbot, *J. Soc. Mot. Pic. Eng.*, June, 1947, p. 569.

For the determination of the curvature of image in projection, a 30 in. screen was constructed having a number of adjustable rods, upon the ends of which focus charts embodied in a special test film were projected, the rods being so adjusted as to bring each test image into sharp focus. Curvature of the field amounted to as much as 20 in. on a 30 in. screen. R. H. C.

PROPERTIES OF THERMISTORS—THERMALLY SENSITIVE RESISTORS.
J. A. Becker, C. B. Green and G. L. Pearson, *Bell System Technical Journal*, Jan., 1947, p. 170.

In this comprehensive survey a full discussion of the theory underlying the use of semiconductors in circuit elements, which vary their resistance with temperature, is followed

by a discussion of their applications. The large negative temperature coefficient (—4% per ° C.) is explained and the existence of a region of negative dynamic resistance. The applications described include the use of these elements as temperature compensators, automatic gain controls, volume expanders and compressors and voltage regulators.

M. V. H.

THE COUNCIL

Meeting of November 12, 1947

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), E. Oram (*Hon. Secretary*), P. H. Bastie (*Hon. Treasurer*), C. Cabirol, R. B. Hartley, B. Honri, A. W. Watkins, R. Pulman (*Representing Theatre Division*), H. S. Hind (*Representing Sub-Standard Film Division*), G. Burgess (*Representing Film Production Division*), and R. H. Cricks (*Secretary*).

S.M.P.E. Convention.—A letter from Mr. A. G. D. West (*Past-President*), stated that he had read two papers to the S.M.P.E. Convention in America, and had had a favourable discussion with the S.M.P.E. President. A cable of congratulation was sent to Mr. West.

Finance Committee.—It was agreed that the financial position, having regard primarily to monthly publication of *British Kinematography*, should be studied by the Finance Committee.

British Kinematography.—Arrangements were reported for the binding of the 1947 issues of *British Kinematography*, and thanks were expressed to Messrs. Kodak for presenting advertising space.

Certificates of Membership.—It was reported that the preparation of certificates was in hand.

Physical Society Exhibition.—A meeting was reported of the Committee appointed to organise the Society's exhibit : the Committee was authorised to proceed with its proposals.

Library Committee.—The Committee was authorised to proceed with the preparation of a duplicated catalogue of the Library.

B.S.I. Glossary Committee.—Meetings were reported of the Sub-Committee appointed to consider words used in the kinema.

B.S.I. Electrical Committee.—In response to a request for representatives, Mr. L. Knopp, chairman of the Committee, was authorised to co-opt suitable members.

Foreign Relations Committee.—Contacts with a number of overseas technical bodies were reported.

Branch Constitution.—Proposals of the Theatre Division Provincial Sections Sub-Committee were confirmed, for modifications to the draft constitution of Branches, for the establishment of Branches, and for minimum membership of Branches.

Film Production Division.—Consideration was deferred of a proposal that the Film Production Division should be empowered to handle television matters.

Publicity for Meetings.—Proposals for increased publicity of meetings were considered.

British Film Academy.—The President was asked to write to Mr. David Lean, chairman of the newly-formed British Film Academy, offering technical co-operation.

Food Parcels from New Zealand.—It was reported that New Zealand exhibitors had very kindly offered to send food parcels to B.K.S. members.

EXECUTIVE COMMITTEE

Meeting of November 12, 1947

Present : Messrs. I. D. Wratten (*President*), W. M. Harcourt (*Vice-President*), E. Oram (*Hon. Secretary*), P. H. Bastie (*Hon. Treasurer*), R. H. Cricks (*Secretary*) and Miss S. M. Barlow (*Assistant Secretary*).

Membership.—The following were elected :—

GORDON HARRY BARNEY (Member), Fortiphone, Ltd.
HARRY PARKER WALKER (Member), I.C.I., Ltd.
GEORGE EDWARD COX (Associate), Simplex-Ampro, Ltd.
DONALD BARTER BROWNING (Student), Polytechnic, Regent Street.
STEWART CALDERWOOD HAMILTON (Member), Gaumont-British Picture Corporation, Ltd.

HANS KUHN (Associate), Army Kinema Corporation, Palestine.
STANLEY KENNEDY (Member), Rex Cinema, Gateshead.
THE TENG HOEI (Member), Java Industrial Films.
ROBIN F. W. GUARD (Student), University College, London.
GWYNETH PARKER (Associate), Rotha Films.
STEPHEN CHUDLEIGH MINCHIN (Student), Denham Studios.
ALFRED ANDREW KEATING (Associate), Gainsborough Studios.
EDWARD MCCORMACK (Associate), Roxy Cinema, Carnforth, Lancs.
JOHN F. TELLAM (Member), British Film Institute.
DAVID CUMMING COUSLAND (Member), Two Cities Films, Ltd.
HAROLD GODART BROWN (Associate), National Film Library.

Transfers.—The following Associates were transferred to Corporate Membership :—
YOUSUFALI ABDULLA FAZALBHOY, Bombay.
HOSHUNG MANDIWALL, Royal Dental Hospital.
LOUIS BERNARD KALLETT HAPPÉ, Technicolor, Ltd.
CHARLES TYLE GIBBS, Kodak, Ltd.
THOMAS EARLE MASEE KNIGHT, D. & P. Studios.
NORMAN ARTHUR KERRIDGE, Associated British Cinemas, Ltd.

Resignations.—The following resignations were regretfully accepted :—
ALISTAIR K. PHILIP (Student).
EDWARD WILLIAM GILLARD (Associate).

The membership of the following was terminated :—
R. J. HORTON (Member).

British Kinematography.—The increased cost of the printing of *British Kinematography* was considered.

B.S.I. ACTIVITIES

The position of work before the Cinematograph Technical Committees of the British Standards Institution was considered at a meeting of the Programme Committee, held on October 30 last. A considerable amount of new work was proposed.

Committee CME/2—Motion Picture Films.—Review of B.S. 677, Motion Picture Films, is in hand : information on American proposals for modification of the 35mm. negative stock standard is awaited before circulating a revised draft.

Committee CME/3—Standard Release Print Reels.—A draft standard for 35mm. Motion Picture Release Prints (in 2,000ft. lengths) is ready, but a reply is awaited from the S.M.P.E. concerning proposals made by the Committee, that the American standard should be modified in regard to the leader, to assist printing of 16mm. as well as 35mm. films.

Committee CME/4—Electrical Equipment.—This committee is being reconstituted, and the following work has been assigned to it : Ripple content in studio supplies ; dimmers ; secondary lighting for kinemas ; Exit and No Exit boxes ; stage electrical equipment ; A.C. inductors for arc lamps ; rating of rectifiers; arc resistors ; feeder controls for carbon arcs ; and projection motors.

Committee CME/5—Projector Equipment.—The need for specifying a standard method of measuring gate temperature is to be considered, in view of the requirements of the draft Home Office regulations.

Committee CME/6—Inflammability of Films.—The desirability of securing Home Office recognition of the existing standard is to be considered.

Committee CME/7—Glossary of Kinematograph Terms.—A number of Sub-committees had been appointed, each to consider words in one section of the industry. Good progress was reported.

Committee CME/8—Tests for Projectors.—Recommendations are awaited from the Incorporated Association of Kinematograph Manufacturers.

Committee CME/9—Exciter Lamps.—The desirability of specifying a maximum permissible sag of the filament was considered, but in view of practical difficulties a decision was deferred.

Committee CME/10—Frequency Characteristics in Recording and Reproduction.—It was agreed to study existing American standards with a view to their adoption.

Committee CME/11—Screen Brightness.—B.S.1404, Screen Brightness for the Projection of 35mm. Film, has been published. Work is to be started on a standard method of determination of brightness.

Committee CME/12—Transformers for Cinema Operation.—No work at present.

Committee CME/13—16mm. Projection and Sound Equipment.—Standards of test films are being finalised, and the possibility of making them in this country is being considered.

Committee CME/15—Cinema Seating.—The proposed standard for cinema seats appeared to be held up by the difficulty of floor rake.

Committee CME/16—Cinema Lenses.—Draft standard for lenses for 35mm. projectors is nearing completion, and work is to be commenced on a similar standard for 16mm. Reports are awaited from the Photographic Committees on methods of determining resolving power, uniformity of illumination, and light transmission.

In course of the meeting of the Programme Committee, it was visited by Mr. J. W. McNair, of the American Standards Association, who was on a brief visit to this country to further co-operation between the two bodies. Several points of mutual interest were discussed.

THE LIBRARY

A catalogue of the Society's Library is now available, price 1s., post free 1s. 3d.

The completion of this catalogue makes it possible to inaugurate postal borrowing of books, and full details of the arrangements made will be found in the catalogue.

S.M.P.E. Journal

The Hon. Librarian is anxious to make up a complete set of the *Journal of the Society of Motion Picture Engineers* from its inception, together with a duplicate set from Vol. 28 (1937) in order to permit of the later volumes being available for borrowing.

The following issues are missing from the Library:

Vol. 15 and earlier (1930 and before)
„ 20 No. 6, June, 1933
„ 21 No. 6, December, 1933
„ 23 No. 5, November, 1934
„ 25 Nos. 1, 2, 3, 4, 5, July, August, September, October and November, 1935
„ 37 Nos. 2, 5, August, November, 1941
„ 40 No. 4, April, 1943
„ 41 Nos. 4, 6, October, December, 1943
„ 42 No. 1, January, 1944
„ 46 Nos. 1, 3, January, March, 1946

The co-operation of members in securing these missing issues will be appreciated by the Library Committee.

A number of bound volumes from 1937 (less those listed above) are available for borrowing.

ILLUMINATING ENGINEERS SOCIETY

The Illuminating Engineers Society is holding two meetings at the Lighting Services Bureau, 2, Savoy Hill, London, W.C.2, during the next few months. The first of these is on January 13th, when a paper, " High Speed Photography," by Dr. J. W. Mitchell, will be read. On April 13th, two papers referring to Film Studio Lighting, the first jointly by Dr. F. S. Hawkins, and Mr. W. P. Stevens, and the second by Mr. F. V. Hauser, will be read.

Both meetings begin at 6 p.m.—B.K.S. members are cordially invited to attend.

PERSONAL NEWS of MEMBERS

H. S. Hind of Sound Services, Ltd., has been elected a Fellow of the Royal Society of Arts.

K. S. Pike, student at Regent Street Polytechnic, has been called to H.M. Forces.

G. Sewell, of Colonial Film Unit, has returned to South Africa, and is not expected back in this country until the end of May, 1948.